

Draft Recovery Plan
Preble's Meadow Jumping Mouse
(*Zapus hudsonius preblei*)
November 5, 2003

U.S. Department of the Interior, Fish and Wildlife Service
Mountain-Prairie Region

Approved _____
Regional Director, U.S. Fish and Wildlife Service

Date _____

U.S. Fish and Wildlife Service's Mission in Recovery Planning

Section 4(f) of the Endangered Species Act (ESA) of 1973, as amended, directs the Secretary of the Interior and the Secretary of Commerce to develop and implement recovery plans for species of animals and plants listed as endangered or threatened unless such plans will not promote the conservation of the species. The Fish and Wildlife Service (FWS) and the National Marine Fisheries Service have been delegated the responsibility of administering the ESA. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured.

The goal of the process is the maintenance of secure, self-sustaining wild populations of species with the minimum necessary investment of resources. A recovery plan delineates, justifies, and schedules the research and management actions necessary to support recovery of a species. Recovery plans do not, of themselves, commit staff or funds, but are used in setting regional and national funding priorities and providing direction to local, regional, and State planning efforts. Means within the ESA to achieve recovery goals include the responsibility of all Federal agencies to seek to conserve endangered and threatened species, and the Secretary's ability to designate critical habitat, to enter into cooperative agreements with the States, to provide financial assistance to the respective State agencies, to acquire land, and to develop Habitat Conservation Plans (HCPs) with applicants.

DISCLAIMER

Recovery Plans delineate reasonable actions that are believed to be required to recover and protect listed species. Plans are published by the FWS, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained, and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the FWS. They represent the official position of the FWS only after they have been signed as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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The fee for the Plan varies depending on the number of pages of the Plan.

A copy of the Plan is available on the Service's website at www.fws.gov

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Many of the threats to the Preble's meadow jumping mouse are associated with habitat loss and urbanization of the east slope of the Rocky Mountain Front Range from Cheyenne, Wyoming, to Colorado Springs, Colorado. To aid in the urban and population planning process, several approved recovery plans were reviewed, and we express our thanks to the authors of other recovery plans, especially the Recovery Plan for Upland Species of the San Joaquin Valley, California, Region 1, U.S. Fish and Wildlife Service 1998, and the Mexican Spotted Owl Recovery Plan, Region 2, U.S. Fish and Wildlife Service 1995.

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EXECUTIVE SUMMARY

Current Species Status: The Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*) was listed as threatened in 1998, pursuant to the ESA. No rangewide population estimates exist for the species. Numerous surveys conducted in the last decade have documented the species presence or absence at locations of suitable habitat; some locations were historically known to be occupied and other locations had no known previous surveys. We believe that adequate numbers, sizes, and distribution of populations may currently exist to meet recovery criteria, but there are substantial threats to these populations that need to be abated to prevent further decline and endangerment of the species. Therefore, the species is still in need of protection of the Endangered Species Act.

Habitat Requirements and Limiting Factors: The Preble's meadow jumping mouse is found in foothills riparian habitat from southeastern Wyoming to south central Colorado. The species is often found in dense, herbaceous riparian vegetation, that may have an overstory canopy layer. Preble's meadow jumping mice regularly use upland grasslands adjacent to riparian habitat, and they may be dependent upon some amount of open water. The species hibernates near riparian zones from mid-October to early May. Loss of riparian habitats and other factors associated with urbanization appear to be the major threat to the species.

Recovery Objective: The purpose of this Plan is to remove the Preble's meadow jumping mouse from the list of threatened species. This plan proposes four criteria for delisting under Section II of the Plan. When the four criteria are met, and following an analysis of the ESA listing factors, the species will no longer be considered in need of protection under the ESA and may be delisted.

Recovery Criteria For Delisting:

1. Document and maintain wild, self-sustaining Preble's meadow jumping mouse populations.
2. Protect and manage habitat of Preble's meadow jumping mouse populations.
3. Abate threats to Preble's meadow jumping mouse populations.
4. Develop and implement a long-term management plan and cooperative agreement prior to delisting.

Guiding Principles and Actions:

1. Manage Species by River Drainage (South Platte, North Platte, Arkansas).
2. Conduct Research on Preble's Habitat and Taxonomy.
3. Use Monitoring and Adaptive Management to Achieve Stable Preble's Populations.
4. Encourage Local Involvement in Conserving Preble's Populations.
5. Encourage Cooperative Management to Achieve Preble's Recovery Efforts.
6. Use Economic Incentives to Encourage Conservation of Preble's Populations.
7. Use Public Education to Achieve Preble's Recovery Objectives.

Cost of Recovery (\$000's): ????

Date of Recovery: Because recovery is defined as populations that are stable or increasing over a period of time, the date of recovery is estimated at approximately 20 years.

The Preble's Meadow Jumping Mouse Recovery Team is a group of stakeholders and interagency scientists convened to advise the FWS on Preble's issues. The Recovery Team wrote the initial draft of this Recovery Plan, which served as the basis for this version. This is the first FWS recovery plan written for this species. Revisions of this Plan will occur as often as is feasible and appropriate.

The Plan is organized into four sections:

- I. Introduction - Species description, taxonomy, distribution, habitat, demography, natural history, reasons for listing, threats to recovery, impediments to recovery, management and conservation efforts, conservation principles and recovery strategies.
- II. Recovery - Recovery objectives and tasks considered vital to the successful recovery of the Preble's meadow jumping mouse.
- III. Implementation Schedule - Scheduled recovery tasks and estimated costs.
- IV. Appendices

We anticipate that this document will be used by agencies and stakeholders involved with Preble's meadow jumping mouse management to coordinate efforts and work towards recovery of this species.

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PART I: BACKGROUND

LEGAL STATUS

Preble's meadow jumping mouse (*Zapus hudsonius preblei*; herein referred to as Preble's) was listed as a threatened subspecies under the ESA in May of 1998 (63 FR 26517). This rare subspecies of meadow jumping mouse is considered "threatened" by the Colorado Division of Wildlife (1998) and of "unknown status" by the Wyoming Game and Fish Department (B. Oakleaf, Wyoming Game and Fish Department, pers. comm.). The species (*Zapus hudsonius*) is protected under the Wyoming Nongame Wildlife Regulations (1999).

Both the Colorado Natural Heritage Program (1999a) and the Wyoming Natural Diversity Database (Fertig and Beauvais 2001) consider Preble's "imperiled globally" and "critically imperiled within the State because of five or fewer occurrences" in their respective States. However, the Wyoming Natural Diversity Database may upgrade the subspecies to status S2 (imperiled within Wyoming because of 6 to 20 occurrences) in the near future (Beauvais 2001). In their recent evaluation of the conservation status of rodents of North America, Hafner et al. (1998) classified Preble's as "endangered" in the International Union for Conservation of Nature and Natural Resources' Red List.

Because there are several other taxa for which include "Preble's" in their common name, referring to this subspecies as "Preble's" is not technically appropriate. Scientifically, it is more appropriate to refer to this subspecies as Zapus hudsonius preblei or Z. h. preblei. Some may feel it would be preferable to use the entire common name, Preble's meadow jumping mouse, or the acronym, PMJM; however, in order to make this plan user friendly for the general public we have chosen to refer to the subspecies as "Preble's," consistent with past FWS usage.

GENERAL BIOLOGY OF PREBLE'S MEADOW JUMPING MOUSE

Much of what is now known about the subspecies is a result of information gained from the early 1990s to the present. Since Preble's was listed by the FWS in 1998, knowledge about distribution, population dynamics, abundance, taxonomy and habitat of the subspecies has grown substantially. However, much of the biology and ecology of Preble's is still not well understood. Where gaps in knowledge exist, scientists have relied on information from closely-related subspecies whose biology and ecology are believed to be similar to Preble's. Information that is specific to Preble's will be described as being relevant to the subspecies ("Preble's"), but when information is gleaned from what is known about other subspecies it will be described as pertinent to the species ("meadow jumping mouse").

Description

Preble's is a relatively small rodent with an extremely long tail, large hind feet and long hind legs (Figure 1). The tail is bicolored, lightly-furred and typically twice as long as the body. The large hind feet can be one third again as large as those of other mice, such as the deer mouse (*Peromyscus maniculatus*). Preble's has a distinct, dark, broad stripe on its back that runs from head to tail and is bordered on either side by gray to orange-brown fur. The hair on the back of all jumping mice appears coarse compared to other mice. The underside fur is white and much finer in texture. Total length of adult Preble's is approximately 180-250 mm (7-10 inches), with the tail comprising 108-155 mm (4-6 in) of that length (Krutzsch 1954, Fitzgerald et al. 1994).

Weights can be used to define three age classes of meadow jumping mice. Juveniles weigh less than 13 g (0.46 oz), subadults weigh 13-14 g (0.46-0.50 oz), and adults weigh 15 g (0.53 oz) or more (Krutzsch 1954, Nichols and Conley 1982). Upon emergence from hibernation, adult Preble's can weigh as little as 14 g (0.50 oz) (Meaney et al. in review, T. Shenk, Colorado Division of Wildlife, and M. Bakeman, Ensight Technical Services, unpublished data). The mean weight of 78 adult male Preble's captured prior to June 18 was 18 ± 2 g (0.65 ± 0.07 oz), and of 47 adult females was 18.2 ± 2.8 g (0.65 ± 0.1 oz); 10 of the females were pregnant and weighed more than 22 g (0.79 oz) (Meaney et al. in review). Pregnant females can reach weights up to 28 g (1.0 oz) or more (M. Bakeman, Ensight Technical Services, unpublished data). Through late August into mid-September, adult Preble's gain weight in preparation for hibernation and typically attain weights of 25 to 34 g (0.89 to 1.2 oz), with these weights comparable to pre-hibernation weights for the species (Muchlinski 1988). However, several individual Preble's have weighed as much as 38 g (1.4 oz) (Meaney et al. in review, T. Shenk, Colorado Division of Wildlife, pers. comm., T Ryon, Greystone Consultants, unpublished data).

Taxonomy

Preble's is a member of the family Dipodidae (jumping mice; Wilson and Reeder 1993), which contains four extant genera. Two of these, *Zapus* and *Napaeozapus*, are found in North America (Hall 1981, Wilson and Ruff 1999). The three species within the genus *Zapus* are *Z. hudsonius* (meadow jumping mouse), *Z. princeps* (western jumping mouse), and *Z. trinotatus* (Pacific jumping mouse). Edward A. Preble (1899) first documented meadow jumping mice from Colorado. Krutzsch (1954) described Preble's as a separate subspecies of meadow jumping mouse. Preble's is now recognized as 1 of 12 subspecies of meadow jumping mouse (Hafner et al. 1981; Figure 2).

The range of the western jumping mouse (*Zapus princeps*) overlaps that of Preble's (Hall 1981; Figure 2) and the two species are similar in appearance. Compared to western jumping mice, Preble's are generally smaller, have a more distinctly bicolored tail, and a less obvious dorsal stripe. However, field identification of western jumping mice and Preble's where their ranges overlap is difficult due to their similarity in size and color. In fact, field identifications have led to some confusion and reversal of identification. A second and better technique for identification of Preble's requires skulls of specimens

housed in natural history museums. With museum identification, one can view the specimen's dental characteristics such as the presence or absence of the anterior median fold on the first lower molar (Klingener 1963, Hafner 1993) and shape of the anteroconid (a tooth cusp) in combination with distribution and elevation. These have been useful tools for almost half a century. A third and more recent technique is discriminant function analysis (DFA) which uses a larger data set comprised of a series of skull measurements in addition to the tooth fold. The DFA suggests that the tooth fold is not a perfect identification tool by itself (Conner and Shenk in press, 2001, Conner and Schenk 2001, and unpublished data). With DFA, two museum identifications from Colorado and seven from Wyoming have been reversed (Conner and Shenk 2001). A fourth technique is genetic analysis (Riggs et al. 1997). Future genetic studies will go a long way toward resolving some of the few identification inconsistencies. A fifth technique is being developed, in which DFA is applied to digitized skull measurements. Overall, most accurate identifications are likely those where two or more approaches produce the same results.

Riggs et al. (1997) analyzed the mitochondrial DNA from tissue samples of meadow and western jumping mice from Colorado and Wyoming and concluded that Preble's form "a homogenous group recognizably distinct from nearby populations and adjacent species of the genus." Hafner (1997) reviewed the Riggs study, and concluded that Preble's do in fact form a relatively homogenous group, as determined by inspection of the original sequence data. Hafner (1997) also remained convinced of the accuracy of the biogeography and taxonomic arrangement of jumping mice.

Studies on genetic relationships between Preble's, and other related species and subspecies are currently being conducted by the Denver Museum of Nature and Science. Results of these studies are not yet available. When these studies have been completed, any available results will be incorporated into the final version of this Recovery Plan.

Two subspecies of meadow jumping mouse occur in Colorado: Preble's and *Z. h. luteus*. The subspecies *Z. h. luteus* was previously known as *Z. princeps luteus*, but was subsequently assigned to *Z. hudsonius* by Hafner et al. (1981). Although *luteus* mainly occurs within central New Mexico and eastern Arizona, it was recently discovered in southern Colorado by Jones (1999). Two subspecies of meadow jumping mouse also occur in Wyoming: Preble's and *Z. h. campestris* (Hall 1981, Clark and Stromberg 1987; Figure 2). The subspecies *Z. h. campestris* was described from northeastern Wyoming, southeastern Montana, and western South Dakota (Hall 1981).

Distribution

Preble's is found in both the North and South Platte River basins, from the eastern flank of the Laramie Mountains and the Laramie Plains in southeastern Wyoming south along the eastern flank of the Front Range in Colorado and into the headwaters of the Arkansas River Basin near Colorado Springs, Colorado (Long 1965, Hall 1981, Clark and

Stromberg 1987, Fitzgerald et al. 1994, Clippinger et al. in review). The most recent knowledge regarding the distribution of Preble's comes from live-trapping locations and specimens from site-specific research efforts, range-wide survey efforts, and numerous additional surveys conducted in Colorado and Wyoming since the mid-1990s. Most specimens collected in recent years are housed at the Denver Museum of Nature and Science; survey reports from live-trapping efforts are filed with the FWS Field Offices in Colorado and Wyoming. Museum specimens from Colorado Springs mark the southern distributional limit of Preble's. At the northern end, museum specimens from the southern notch of Converse County mark the limit; trapping records of *Zapus* are recorded as far north as Douglas, Wyoming (Rodgers 1999), but it is not known whether these are Preble's (Figure 3, Appendix C and D).

The ranges of Preble's and the western jumping mouse overlap in Colorado and southeastern Wyoming (Long 1965, Clark and Stromberg 1987; Figure 2). Many drainages are inhabited by both Preble's and the western jumping mouse. The general pattern is one of elevational gradient, where *Z. princeps* occurs at higher elevation and *Z. h. preblei* occurs at lower elevation. This pattern manifests itself along the Front Range in Colorado and the eastern flank of the Laramie Mountains in Wyoming. In some of the drainages, a number of specimens of one species have been collected as well as a single specimen of the other species. This may be the result of individual mice traveling up- or downstream to a population of the other species. Preble's are able to travel long distances (Ryon 1999, Shenk and Sivert 1999a) and meadow jumping mice are not aggressive toward conspecifics in captivity (Whitaker 1963). These behaviors may contribute to the frequency with which both species may occur at a particular site.

There are two drainages where both species appear to occur over a distance of 13 kilometers (8 miles) or more and from which at least two specimens of each species have been collected: Trout Creek in Douglas and Teller counties, Colorado and the Laramie River drainage in Wyoming. Trout Creek heads in the Rampart range, flows north through rolling hills, and empties into the South Platte. In Wyoming, the Laramie River provides access for Preble's to the Laramie Plains. Whereas most of the Laramie Mountains have a "divide" along the top which restricts Preble's to the eastern flank, the Laramie River flows through a low saddle enabling Preble's to come upstream onto the Laramie Plains. The western jumping mouse comes downstream from the higher-elevation headwaters in the mountains of Larimer County, Colorado. A study of the ecological separation of the two species would be of considerable interest.

Zones of co-occurrence raise the question of hybridization (Beauvais 2001). In New Mexico and Arizona, *Z. hudsonius* and *Z. princeps* coexist in narrow zones of contact where limited hybridization between the two species may occur (Hafner 1997). However, Krutzsch (1954) looked at areas of potential hybridization and found no evidence of hybridization at the species level. Future genetic studies will likely clarify this issue.

There is very little information on the past distribution or abundance of Preble's. Over the past

decade, numerous surveys have been undertaken within the subspecies range. Many of these surveys have been conducted in suitable habitat at locations that had not previously been surveyed and often have documented Preble's presence. These new surveys do not represent a substantial range expansion of the subspecies nor do they provide evidence of increased subspecies abundance, as Preble's were and still are presumed present in suitable habitats within the subspecies' current range. The new surveys document this presence, but do not provide information on trend of the Preble's populations at most of the sites.

Surveys have identified various locations where the subspecies was historically present but is now absent (Ryon 1996). Despite increased trapping, Preble's has not been found in Denver, Adams, and Arapahoe Counties in Colorado in the past decade (Colorado Natural Heritage Program 1999b, Clippinger et al. in review). Their absence in these counties is likely due to urban development, which has reduced, altered, or completely eliminated riparian habitat (Compton and Hugie 1993, Ryon 1996). This represents a large hole in the middle of Preble's range and underscores the effect that extensive urbanization can have on the distribution of the subspecies. The loss of habitat has been so extensive in the Denver metropolitan area that the FWS has "block-cleared" portions of Denver, Adams, and Arapahoe Counties. Block clearance indicates that due to loss of habitat, the FWS believes that Preble's is no longer likely to exist in the area. However, should Preble's be found within this area in the future, it would be fully protected under the ESA.

The semi-arid climate of southeastern Wyoming and eastern Colorado limits the extent of riparian (river) corridors and restricts the range of Preble's within this region. Preble's is likely an Ice Age relict (Armstrong 1972, Hafner et al. 1981); once the glaciers receded from the Front Range of Colorado and the foothills of Wyoming and the climate became drier, the mouse was confined to riparian systems where moisture was more plentiful. Preble's has not been found east of Cheyenne, Wyoming, or on the extreme eastern plains in Colorado (Beauvais 2001, Clippinger et al. in review). The eastern boundary for the subspecies is likely defined by the dry shortgrass prairie, which may present a barrier to eastward expansion (Beauvais 2001). In a modeling study of Preble's habitat associations in Wyoming, Keinath (2001) predicted extensive habitat in the Laramie Basin and Snowy Range Mountains, but limited habitat in Goshen, Niobrara, and eastern Laramie Counties.

Preble's is generally found at elevations between 2,318 m (7,600 ft) and 1,418 m (4,650 ft) (U.S. Fish and Wildlife Service 1998a), although elevations may vary across the range of the subspecies. The lowest elevation Preble's specimen is from Greeley, Colorado, at 1,218 m (3,983 ft) (Armstrong 1972). The highest elevation specimen is from Middle Lodgepole Creek in Albany County, Wyoming, at 2,430 m (7,970 ft) (DMNH #9569). This latter specimen has a museum identification of Preble's, and has not been included in a DFA.

Reproduction

Little research has been done on the number or size of Preble's litters, but it is assumed that they are similar to other subspecies of meadow jumping mouse. Meadow jumping mice usually have two litters per year (Whitaker 1963, 1972), but Quimby (1951) lists records of three litters per year. The size of a litter can range from two to eight young but averages five young (Quimby 1951, Whitaker 1963). A Preble's nest with six young was found in Jefferson County, Colorado (Ryon 2001). After 4 weeks of age, meadow jumping mouse young are independent and resemble adults (Whitaker 1963). First reproduction can occur at 2 months of age for young of early litters (born in June); young of later litters appear to have their first reproduction in the next year (Quimby 1951).

Longevity and Mortality

Preble's annual survival rate is low, and appears to vary seasonally. As is typical of many small rodent species, the lifespan is short. The Preble's seems to survive fairly well during winter hibernation; most of the mortalities probably occur when the subspecies is active during the summer. Summer survival rates, defined as June through August or October, ranged from 9 to 37%. Over-winter survival rates, defined as August or October to May or June, ranged from 9 to 76% (Shenk and Sivert 1999b; Ensign Technical Services 2001; Schorr 2001; Meaney et al. in review; Bruce Lubow, Colorado State University, pers. comm.). A model was fit to these data to account for the different lengths of time between trapping sessions in each study and in order to include Shenk's (date) estimates for summer only. Based on this fitted model, Preble's average summer survival standardized to 4 months was 11.0% (5.6% standard error) and average winter survival over 8 months was 83.4% (8.8% standard error). The average annual survival rate (summer rate x winter rate) based on the full data set was 9.1% (5.2% standard error) (Bruce Lubow, Colorado Division of Wildlife, unpublished data). These annual survival rates are based upon limited field observation, and may change as additional information is obtained.

Causes of Mortality

Preble's have a host of known predators including garter snakes (*Thamnophis* spp.), prairie rattlesnakes (*Crotalus viridis*), bullfrogs (*Rana catesbiana*), foxes (*Vulpes vulpes* and/or *Urocyon cinereoargenteus*), house cats (*Felis catus*), long-tailed weasels (*Mustela frenata*), and red-tailed hawks (*Buteo jamaicensis*) (Shenk and Sivert 1999a, Schorr 2001). Other potential predators of jumping mice include coyotes (*Canis latrans*), barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), northern harriers (*Circus cyaneus*), northern pike (*Esox lucius*), and creek chub (*Semolilus atromaculatus*) (Whitaker 1963, Poly and Boucher 1997).

Other mortality factors for Preble's include drowning and occasional losses associated with vehicles (Shenk and Sivert 1999a, Schorr 2001). Mortality factors known for other subspecies of meadow jumping mice, including starvation, exposure, disease, cannibalism, and insufficient fat stores for hibernation (Sheldon 1934, Whitaker 1963)

also are likely causes of death for Preble's.

Abundance

White and Shenk (2000) determined that riparian shrub cover, tree cover, and the amount of open water nearby are predictors of Preble's densities. These researchers also summarized abundance estimates from nine sites in Colorado for field work conducted during 1998 and 1999 (Shenk and Sivert 1999b; Meaney et al. 2000; Kaiser-Hill 2000; Ensight Technical Services 1999, 2000, 2001; Schorr 2001). Since Preble's are found in linear riparian communities, abundances are estimated in number of individuals per mile or kilometer of stream corridor. Estimates of linear abundance ranged from 6 to 107 mice/mi (4 to 67 mice/km) with a mean of 53 mice/mi (33 mice/km; standard error = 8 mice/mi or 5 mice/km, sample size = 15 sites; White and Shenk 2000, T. Shenk, Colorado Division of Wildlife, pers. comm.). The subsequent addition of new sites and 2 more years of data (2000-2001), for a total sample size of 25 sites, provided a mean of 44 mice/mi (27 mice/km; standard error = 6 mice/mi or 4 mice/km), and a range of 3 to 107 mice/mi (2 to 67 mice/km) (T. Shenk, Colorado Division of Wildlife, unpublished data, R. Schorr, Colorado Natural Heritage Program, unpublished data, C. Meaney, University of Colorado, unpublished data, T. Ryon, Greystone Consultants, unpublished data, M. Bakeman, Ensight Technical Services, unpublished data, and M. Fink, Exponent, unpublished data).

Diet

Although fecal analyses have provided the best data on Preble's diet to date, they overestimate the components of the diet that are less digestible. Those food items that are digested more completely, such as vegetation, are not as easily detected in fecal samples and are likely under-represented in the following fecal analyses: Based on fecal analyses, Preble's eat arthropods, fungus, moss, pollen, willow, lamb's quarters (*Chenopodium* sp.), Russian thistle (*Salsola* sp.), sunflowers (*Helianthus* spp.), sedge (*Carex* spp.), mullein (*Verbascum* sp.), grasses (*Bromus*, *Festuca*, *Poa*, *Sporobolus* and *Agropyron* spp.), bladderpod (*Lesquerella* sp.), rushes (*Equisetum* sp.), and assorted seeds (Shenk and Eussen 1998, Shenk and Sivert 1999a). Willows were present in 38% of scats from Larimer County, Colorado (Shenk and Eussen 1998). The diet shifts seasonally, consisting primarily of arthropods and fungus after emerging from hibernation and fungus, moss, and pollen during mid-summer (July-August), with arthropods added again in September (Shenk and Sivert 1999a). The shift in diet along with shifts in mouse movements suggest that Preble's may require specific seasonal diets, especially with the physiological constraints imposed by hibernation (Shenk and Sivert 1999a).

Hibernation

Preble's is a true hibernator, usually entering hibernation in September or October and emerging the following May, after a potential hibernation period of 7 or 8 months. Adults are the first age group to enter hibernation because they accumulate the necessary fat stores earlier than young-of-the-year (Wunder and Harrington 1996). Adults reach weights that enable them to enter hibernation by the third week in August, whereas young-of-the-year

typically enter hibernation in September and October (Meaney et al. in review). The earliest Preble's capture in Colorado was May 3 and the latest was October 27; both were captured at Rocky Flats Environmental Technology Site in 1995 (Bakeman 1997a). As with other subspecies of meadow jumping mouse, Preble's do not store food, but survive on fat stores accumulated prior to hibernation (Whitaker 1963).

Meadow jumping mice dig their own hibernation burrows and are solitary hibernators.

However, the separate hibernacula may be located close together (Whitaker 1972). Hibernation sites found for Preble's were located within 100 m (328 ft) of the 100-year flood plain of the main stream (T. Shenk, Colorado Division of Wildlife, unpublished data). One confirmed Preble's hibernaculum, located at Rocky Flats Environmental Technology Site, was found 9 m (29 ft) above the creek bed, in a dense patch of chokecherry and snowberry (Bakeman and Deans 1997). The nest was in leaf litter 30 cm (12 in) below the surface in coarse textured soil (M. Bakeman, Ensight Technical Services, pers. comm.). Two suspected hibernacula were found at this site when telemetry locations were stationary over several weeks in September. One was 76 m (250 ft) from the creek on a hill in chokecherry/hawthorn upland shrubs, and the other was 0.6 m (2 ft) from the edge of the water (T. Ryon, Greystone Consultants., pers. comm.). Four possible hibernacula, found by following radio-telemetered mice at the U.S. Air Force Academy, were located in the vicinity of coyote willow (*Salix exigua*) at 7, 12, 29, and 31 m (23, 39, 95, and 102 ft, respectively) from a creek bed (R. Schorr, Colorado Natural Heritage Program, unpublished data). Ten possible hibernacula in Douglas County were located between 1 and 78 m (3 and 256 ft) from either a main drainage or tributary (three sites at Woodhouse Ranch, six sites at Pine Cliff Ranch, and one at Maytag Property), and one was located at a distance of 750 m (2,460 ft) from the from the main drainage (Shenk and Sivert 1999a).

Behavior

Knowledge of a species' behavior is an essential component of developing a successful conservation program (Caro 1998, Gosling and Sutherland 2000), yet very little is known about the behavior of meadow jumping mice. Preble's is primarily nocturnal or crepuscular but also may be active during the day, when they have been seen moving around or sitting still under a shrub (Shenk 1998, M. Bakeman, Ensight Environmental., pers. comm.). Meadow jumping mice are not antagonistic toward one another (Whitaker 1972). Jumping mice compete with meadow voles and may be kept at low densities by these voles (Boonstra and Hoyle 1986). A meadow jumping mouse was killed by a meadow vole (*Microtus pennsylvanicus*) when the two were confined together (Quimby 1951).

Preble's construct day nests composed of grasses, forbs, sedges, rushes, and other available plant material. They may be globular in shape or simply raised mats of litter, and are most commonly above ground but also can be below ground (Ryon 2001, Bain and Shenk 2002). They are typically found under debris at the base of shrubs and trees, or in open grasslands (Shenk and Sivert 1999a, Ryon 2001, Schorr 2001). An individual mouse can

have multiple day nests in both riparian and grassland communities (Shenk and Sivert 1999a, Schorr 2001). Preble's may abandon use of a day nest after approximately a week of use (Ryon 2001).

Little is known about the interaction of social behavior, social strategies, and survival in this subspecies. However, E. A. Preble (as cited in Warren 1942) described globular nests built above ground in late summer to be inhabited by two individuals, presumably a pair. Jones and Jones (1985) described lively social interactions in which several meadow jumping mice were observed jumping into the air and squeaking in close proximity to one another; the authors then captured four of these mice at the base of the shrub where the behavior occurred, and suggested that they formed a gregarious unit. At Woodhouse Ranch in 1999 and 2000, three radio-collared Preble's came from different day-nest locations to meet at one particular spot every night for the month that their radio-collars were active (T. Shenk, Colorado Division of Wildlife, pers. comm.).

Habitat

Typical habitat for Preble's is comprised of well-developed riparian vegetation with adjacent, relatively undisturbed grassland communities and a nearby water source (Bakeman 1997b). Well-developed riparian vegetation includes a fairly dense combination of grasses, forbs, and shrubs; a taller shrub and tree canopy may be present (Bakeman 1997b). Preble's are typically captured in areas with multi-storied cover with an understory of grasses or forbs or a mixture thereof (Bakeman 1997b; Bakeman and Deans 1997; Meaney et al. 1997a, 1997b; Shenk and Eussen 1998; Schorr 2001). The shrub canopy is often willow (*Salix* spp.), although other shrub species, such as snowberry (*Symphoricarpus* sp.), chokecherry (*Prunus virginiana*), hawthorn (*Crataegus* sp.), Gambel's oak (*Quercus gambelli*), alder (*Alnus incana*), river birch (*Betula fontinalis*), skunkbrush (*Rhus trilobata*), wild plum (*Prunus americana*), lead plant (*Amorpha fruticosa*), dogwood (*Cornus sericea*), and others also may occur (Bakeman 1997b, Shenk and Eussen 1998).

Adjacent uplands used by the mouse are extremely variable, and range from open grasslands to ponderosa pine (*Pinus ponderosa*) woodlands (Corn et al. 1995, Pague and Grunau 2000). The montane riparian woodlands where Preble's has been found are dominated by Ponderosa pine, Douglas fir (*Pseudotsuga menziesii*), spruce (*Picea pungens*), and occasionally aspen (*Populus tremuloides*), with lush and diverse understories of shrubs and forbs (Ruggles et al. 2001). Hayfields are used by Preble's in some situations (Meaney et al. 1997b, Bakeman and Meaney 2001). Additional areas used by Preble's include shrub patches set back from the drainage (T. Shenk, Colorado Division of Wildlife, unpublished data), and downed woody debris, which creates good cover for day nests (R. Schorr, Colorado Natural Heritage Program, unpublished data). Occasionally, riparian patches with thick cover are interspersed with more open patches which may provide important movement corridors between dense vegetation patches (Bakeman and Meaney 2001).

Preble's have rarely been trapped in uplands adjacent to riparian areas (PTI Environmental 1998, Corn et al. 1995, Meaney et al. 1996, Bakeman 1997a, Dharman 2001). However, radio-telemetry studies of Preble's movement patterns have documented individuals feeding and resting in adjacent uplands (Shenk and Sivert 1999b, Ryon 1999, Schorr 2001). These studies indicate that Preble's regularly use uplands at least as far out as 100 m (328 ft) beyond the 100-year flood plain (T. Shenk, Colorado Division of Wildlife, unpublished data, R. Schorr, Colorado Natural Heritage Program, unpublished data), and 243 m (794 ft) from the drainage (Ryon 1999). Since 1999, the FWS has recommended that projects within 92 m (300 ft) of the 100-year flood plain of rivers and streams, and projects that may have secondary impacts to such areas be assessed for their potential to impact Preble's and its habitat. Preble's also can move over 1 km (0.6 miles) along streams within a 24-hour period, with maximum recorded movements of 1.6 km (1 mi) (Ryon 1999, Shenk and Sivert 1999a).

In a rangewide comparison of existing habitat data from Colorado, Clippinger (2002) found that subshrub cover and plant species richness are higher at most sites where meadow jumping mice are present versus where they are absent, particularly at 15 to 25 m from streams. In a study comparing Preble's capture locations on the Rocky Flats Environmental Technology Site and the U.S. Air Force Academy (Academy), the Academy sites had lower plant species richness at capture locations but considerably greater numbers of Preble's (Schorr 2001). It may be that the density of Preble's is not driven by the richness of plant species alone, but also by the density and abundance of riparian vegetation (Schorr 2001). However, there is concern about monocultures of vegetation (i.e. cultivated agriculture) and their effect on Preble's.

One definite and 14 possible Preble's hibernacula, or hibernation nests, have been located; they were all between 1 and 78 m (3 and 256 ft) from a main drainage or tributary (Bakeman and Deans 1997, Shenk and Sivert 1999a, R. Schorr, Colorado Natural Heritage Program, unpublished data). Hibernacula have been located under willow, chokecherry, snowberry, skunkbrush, sumac (*Rhus* sp.), clematis (*Clematis* sp.), cottonwoods (*Populus* sp.), Gambel's oak, thistle (*Cirsium* spp.), and alyssum (*Alyssum* sp.; Shenk and Sivert 1999a).

Hydrologic regimes that support Preble's habitat range from large perennial rivers such as the South Platte River (Armstrong 1972, Colorado Natural Heritage Program 1999b) to small ephemeral drainages only 1 to 3 m (3 to 10 ft) in width, as are found at Rocky Flats Environmental Technology Site (Bakeman and Deans 1997) and in montane habitats. Although Preble's commonly uses riparian vegetation immediately adjacent to a stream, other features that provide habitat for the mouse include seasonal streams (Bakeman 1997b), which are common in Colorado and southeastern Wyoming, low moist areas and dry gulches (T. Shenk, Colorado Division of Wildlife, unpublished data), agricultural ditches (Meaney et al. in review), and wet meadows and seeps near streams (Ryon 1996).

Flooding is a common and natural event in the riparian systems along the Front Range of Colorado, with major flooding events occurring at least once every 5 to 20 years (Follansbee and Sawyer 1948, U.S. Army Corp of Engineers 1984). Some of the most severe and frequent flooding events occur within Preble's habitat along the South Platte and Arkansas River drainages along the Front Range (Follansbee and Sawyer 1948). This periodic flooding helps to create a dense vegetative community by stimulating resprouting from willow shrubs and allowing forbs and grasses to take advantage of newly-deposited soil (Gregory et al. 1991). Changes to plant communities can be caused by regular flooding events, plant succession, native and nonnative herbivory (grazing or browsing), water table fluctuations, fire, and other natural and human-driven impacts (Gregory et al. 1991, Gordon et al. 1992, Busch and Scott 1995, Pague and Grunau 2000) and invasive noxious weeds (check citations for mention of invasives).

REASONS FOR LISTING AND THREATS TO RECOVERY

Several factors may have played a role in reducing the range and abundance of Preble's. The following items have been identified as potential threats to their populations and recovery. Much of the following discussion comes from the Preble's Science Team's Threat Assessment (Pague and Grunau 2000) and the rule listing the mouse under the ESA (63 FR26517).

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range

Changes in habitats and their component plant communities affect the composition of the mammalian community found within them (Andersen et al. 1980, Honeycutt et al. 1981).

Preble's is closely associated with riparian ecosystems that are relatively narrow and represent a small percentage of the landscape. If habitat for Preble's is destroyed or modified, populations in those areas will decline or be extirpated. The decline in the extent and quality of Preble's habitat is considered the main factor threatening the subspecies (Hafner et al. 1998, Shenk 1998). As stated in the rule listing the mouse under the ESA (63 FR 26517), habitat alteration, degradation, loss, and fragmentation resulting from urban development, flood control, water development, agriculture and other human land uses have adversely impacted Preble's populations. Conversion of habitats from native riparian ecosystems to commercial croplands and grazed rangelands was identified as the major threat to their persistence in Wyoming (Clark and Stromberg 1987, Compton and Hugie 1994).

Habitat fragmentation also limits the extent and abundance of Preble's populations. As populations become fragmented and isolated, it becomes more difficult for them to persist (Caughley and Gunn 1996). Smaller patches of habitat are unable to support as many Preble's as larger patches of habitat. If the threats to persistence are the same, larger populations are believed to be more secure from extinction than smaller ones (Primack 1998).

i. Habitat Conversion, Habitat Destruction, and Habitat Fragmentation Through Housing, Commercial, Recreational, and Industrial Construction

Residential, recreational, and commercial development, accompanied by highway and bridge construction, directly removes, reduces, alters, fragments, and/or isolates Preble's habitat to the point where populations no longer can persist. These factors may impact the subspecies by destroying its nests, food resources, and hibernation sites, by disrupting behavior, or by acting as barriers to movement. A study in Boulder County found that as the degree of proximity to urban environments increased, the number of small mammals captured decreased (Bock et al. 1998).

Despite numerous surveys, Preble's has not recently been found in the Denver and Colorado Springs metropolitan areas, and is believed to be extirpated from there as a result of extensive urban development. In recognition of the impact of urban development on Preble's populations, the FWS has established "block clearance" zones in the Denver metropolitan area, along Monument Creek through downtown Colorado Springs, and along the majority of Cottonwood Creek, El Paso County, Colorado, and its tributaries, where Preble's is no longer believed to exist and where no further surveys are needed to determine its absence.

ii. Hydrology Impairments and Ground Water Flow Alterations

Establishment and maintenance of riparian plant communities are determined by the interactions between surface water dynamics, groundwater, and river channel processes (Busch and Scott 1995). Changes in hydrology can alter the channel structure, riparian vegetation, and valley floor landforms (Gregory et al. 1991). Thus, changes in the timing and abundance of water may be detrimental to the persistence of Preble's in these riparian habitats due to resultant changes in vegetation. Such changes in hydrology may occur in many ways, but two of the more prevalent are the disruption of natural flow regimes below dams, and "boom and bust" runoff cycles in watersheds with increased areas of paved or hardened surfaces that preclude water percolation.

Similarly, depletion of groundwater via wells and water diversions also affects the vegetation within Preble's habitat. As groundwater supplies are depleted, more xeric plant communities replace the riparian vegetation. The conversion of these habitats from mesic, shrub-dominated systems to drier grass-dominated systems would preclude Preble's from these areas.

iii. Rock and Sand Extraction

Alluvial aggregate extraction may produce long-term changes to Preble's habitat by altering hydrology and removing riparian vegetation. In particular, such extraction usually removes or precludes the development of riparian shrub and herbaceous vegetation.

Armstrong speculated that mining impacts the deposits of alluvial sands and gravels that may be important hibernation locations for Preble's (D. Armstrong, University of Colorado, pers. comm.).

iv. Bank Stabilization and Channelizing of Waterways

Bank stabilization, channelization, and other methods of hardening stream banks increases the rate of stream flow, straightens riparian channels, and narrows riparian areas (Pague and Grunau 2000). Creating impervious cement channels destroys riparian vegetation and precludes its reestablishment. Using riprap and other structural stabilization options to reduce erosion can destroy riparian vegetation and prevent or prolong its establishment. These impacts can alter the plant composition, soil structure, and physiography of riparian systems to the point that Preble's can no longer persist there.

v. Farming and Ranching Operations

Intensive haying and ditch maintenance operations may negatively impact Preble's by removing food and shelter resources. While it is believed that most haying operations that allow riparian vegetation to remain in place may be compatible with persistence of Preble's populations, further study is needed.

vi. Transportation Corridor Maintenance, Construction and Accidents

Transportation corridors frequently cross Preble's habitat and may negatively affect adjacent populations. As new roads are built and old roads are maintained, the habitat is destroyed and possibly fragmented. Roads also may act as barriers to dispersal. Train and truck accidents within riparian areas may release spills of chemicals, fuels and other substances that may impact the mouse or its habitat.

vii. Noxious Weeds

Invasive, noxious plants can encroach upon a landscape, displace native plant species and form monocultures of vegetation. This change reduces the abundance and diversity of native plants, and may negatively impact cover and food sources. The control of noxious weeds may entail large-scale removal of vegetation and mechanical mowing operations, which also may impact Preble's.

The tolerance of Preble's for invasive plant species is not well understood. Whether or not invasive plant species reduce Preble's persistence at a site may be due in large part to whether they create a monoculture and replace native species. There is concern about nonnative species such as Russian olive (*Elaeagnus angustifolia*) and leafy spurge (*Euphorbia esula*). Leafy spurge may be of particular concern, since it may form a monoculture, displacing native vegetation and thus reducing available habitat (Selleck et al. 1962). Within Larimer and Weld Counties of Colorado, Russian olive occurred in six

(33 %) of the areas where no jumping mice were found, while it was absent in areas where jumping mice were captured (Shenk and Eussen 1998). However, Russian olive was present in Wyoming sites where jumping mice were captured (R. Taylor, True Ranches, pers. comm.).

viii. Recreational Trail Development and Use

Trail systems frequently parallel or intersect riparian communities within Colorado. The development of trail systems may impact Preble's by modifying its habitat, nesting sites, and food resources in both riparian and upland areas. Humans and pets using these trails may alter behavior patterns of Preble's and cause a decrease in survival and reproductive success. There was a 28% decrease (although not statistically significant, $p = 0.226$) in population density of Preble's adjacent to trails, compared with sites without trails along South Boulder Creek, Boulder County (Meaney et al. in press).

ix. Utilities and Ditch Construction and Maintenance

Many utility lines (sewer, water, communications, gas, electric, municipal water ditches) cross Preble's habitat. Current and future utilities right-of-ways through these habitats may represent a threat from habitat fragmentation via new construction, toxic chemical spills, and habitat disturbance during construction and periodic maintenance. However, utility corridors are currently short term disturbances, due to project review and reclamation required since listing in 1998.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Preble's is not collected for commercial or recreational reasons. Some collection of specimens may occur for scientific and educational purposes, but only through permits issued by the FWS. This factor is not considered a threat to the subspecies.

Factor C. Disease or Predation

i. Disease

As with most small mammals, Preble's carries parasites and diseases that may reduce vigor, curtail reproductive success, and cause death. There is no evidence that any disease has caused a significant impact to populations. A rare parasitic fly caused the only documented mortality due to parasitism (Schorr and Davies in press). Currently known parasites and disease are not considered to be a threat to this subspecies.

ii. Predation

Predation is a natural occurrence in Preble's populations, and would not normally be considered

a threat. However, the increasing presence of humans near Preble's habitats may result in an increased level of predation that may pose a threat to the mouse. Striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), red foxes (*Vulpes vulpes*) and domestic and feral cats are found in greater densities in and around areas of human activity; all four of these species feed opportunistically on small mammals (Churcher and Lawton 1987, Rosatte et al. 1991). Therefore, Preble's populations that are near suburban settings are subjected to greater predation. The predation pressure from domestic cats can be particularly difficult to mediate since these predators will hunt regardless of their lack of a need to sustain themselves (Adamec 1976). Introduction of non-native aquatic species, such as bullfrogs, has resulted in additional predation on the subspecies. The fact that summer mortality is higher than overwinter mortality, as discussed under *Longevity and Mortality*, underscores the impact that predators can have on Preble's and other small mammals.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

The decline of Preble's is partly due to the lack or ineffectiveness of existing laws that could protect the mouse and its habitat. Various existing Federal laws, such as the Clean Water Act, the ESA (prior to listing of the subspecies), Federal Power Act, Fish and Wildlife Coordination Act, Food Security Act, and National Environmental Policy Act have not been effective in the past to protect occupied riparian habitat. The listing of Preble's (*Zapus hudsonius preblei*) under the ESA provides a level of protection that increases the likelihood of conserving the subspecies.

Considered threatened under the nongame provisions of the Colorado Division of Wildlife, Preble's can only be taken legally by permitted personnel for educational, scientific, or rehabilitation purposes. The Wyoming Game and Fish Department considers all meadow jumping mice (*Zapus hudsonius* spp.) as "nongame species," which are protected under Wyoming Nongame Wildlife Regulations (1999). Although these Colorado and Wyoming State regulations prohibit the take of individual mice, they do not protect Preble's habitat.

Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence

i. Pesticide and Herbicide Use

Pesticides and herbicides are used within the range of Preble's for pest control, weed control, and other agricultural purposes. These chemicals may poison Preble's directly, or be detrimental to the vegetation in its habitat. Overall, an integrated pest management approach (use of biological, chemical and mechanical control) may help reduce the threat of chemicals, but allow for the control of unwanted species.

ii. Fire

Fire is a natural component of the Colorado Front Range and Wyoming foothill systems and *Z. h. preblei* habitat naturally waxes and wanes with fire events. Overall, fire may be one of the methods needed to maintain riparian, transitional, and upland vegetation within Preble's habitat. In a review of the effects of grassland fires on small mammals, Kaufman et al. (1990) found a positive effect of fire on *Z. hudsonius* in one study and no effect of fire on the species in another study.

Over the past several decades, as human presence has increased in and near Preble's habitat, significant effort has been made to suppress fires. Long periods of fire suppression may result in a build-up of fuel and result in a catastrophic fire. As with many natural catastrophes, fire can kill mice and alter habitat (Howard et al. 1959). Although there are no records of fire killing *Z. h. preblei*, it is possible that fire may take a limited number of individuals. Catastrophic fire in particular can alter habitat dramatically, changing the structure and composition of the vegetation communities such that Preble's may no longer persist. Precipitation falling in a burned area may degrade the subspecies' habitat by causing greater levels of erosion and sedimentation along creeks.

iii. Exotic Animals

Exotic animals that occupy riparian habitats may displace, prey upon, or compete with Preble's. Domestic cats have preyed upon the mouse in Colorado (Shenk and Sivert 1999a). Feral cats and house mice (*Mus musculus*) were common in and adjacent to historic capture sites where Preble's were no longer found (Ryon 1996). Preble's is 13 times less likely to be found at sites where house mice are present (Clippinger 2002). Bullfrogs also have been known to prey on Preble's (T. Shenk, Colorado Division of Wildlife, pers. comm.).

iv. Water Quality

The quality of the water in riparian habitats may affect the survival and abundance of Preble's. Point sources of pollution such as fuel and chemical waste spills or sanitary/sewer drains can degrade the water quality of an area. Nonpoint sources of pollution such as urban or agricultural runoff can affect riparian systems as well.

v. Alteration of Vegetation Succession

Flooding and fire events may temporarily impact Preble's by removing some riparian habitat. However, normal flooding and fire events help maintain the willow communities that provide suitable habitat for the subspecies. Increasing the paved surfaces within a water drainage can result in increased flood events and prevent the re-establishment of riparian communities.

vi. Stochastic Demographic, Genetic, and Environmental Effects

Stochastic, or random, changes in a wild population's demography, genetics, and environment can threaten its persistence (Brussard and Gilpin 1989, Caughley and Gunn 1996). A

stochastic demographic change such as a skewed age or sex ratio (for example, a sudden loss of adult females) could negatively affect reproduction, especially in a small population. Disruption in gene flow due to reduction and isolation of populations may create unpredictable genetic effects that could impact Preble's persistence in an area. While stochastic events are not known to be a threat to Preble's populations at this time, the likelihood of such events may increase as populations become smaller and more isolated in the future. Flooding is an example of a stochastic event that commonly occurs in Preble's habitat. An extreme flooding situation could eliminate an entire Preble's population in an affected stream reach or drainage. Habitat may be recolonized after such events if there are occupied, connected tributaries or mainstem stretches that were not flooded.

IMPEDIMENTS TO RECOVERY

Several additional factors exist that may hamper the potential for recovery of Preble's. These relate to the implementation of the plan, but are not in themselves threats to the mouse. Implementation of the recovery plan requires the ability to resolve factors threatening the subspecies and to protect sufficient habitat and populations for the taxon to persist over the long term, making the protection of the ESA unnecessary. There is limited funding and staff available to manage and protect habitat, even on public lands where protection should be most easily accomplished. Most habitat occurs on private lands and there is a lack of incentives available to assist private landowners in managing and protecting habitat. A lack of coordination of efforts between State and local regulatory bodies may result in conflicts in habitat management direction, but most conflicts can be resolved. Examples of conflict areas may be recreational development, flood control, wildland fire protection, and highway projects. Additional funding and attention from all involved parties will be needed to successfully implement this recovery plan.

MANAGEMENT AND CONSERVATION EFFORTS

Starting in the early 1990s, Federal, State, local, and private groups have worked to conduct research, habitat management, and conservation planning, which have formed the basis for the listing of the subspecies and development of this Recovery Plan.

Research

Research efforts for Preble's increased in the early 1990s. Research conducted by Armstrong et al. (1996, 1997), Bakeman (1997a), Meaney and Clippinger (1995), Meaney et al. (1996), and Ryon (1996) was compiled by Bakeman (1997b) into one document that provided the state of knowledge on Preble's habitat. Research also was conducted by Bruce Wunder of Colorado State University to help clarify the physiology and genetics of Preble's (Wunder and Harrington 1996, Wunder 1998). Many presence/absence surveys contributed to knowledge of the subspecies' distribution and can be found at the FWS offices, Colorado Natural Heritage Program (1999b), and Wyoming Natural Diversity

Database. Recent research has focused on population demographics at a number of different sites (White and Shenk 2000, 2001). Other studies include the impact of recreational trails (Meaney et al. in press), morphometric analyses (Conner and Shenk in review), radio-telemetry studies of movement patterns (Dharman 2001, Ensight Technical Services 1999, Ryon 1999, Shenk and Sivert 1999a, Schorr 2001), and nest descriptions (Ryon 2001, Bain and Shenk 2002). Most of the information gathered through this research appears in the Biology Section of this Plan.

Habitat Conservation

In order to conserve riparian habitat and Preble's populations, land easements and acquisitions have been purchased by non-governmental organizations, public agencies, and private land owners. Examples of these actions include, but are not limited to: acquisition of the Circle Ranch in Larimer County, Colorado, and the Greenland Ranch easement in Douglas County, Colorado. Also, the FWS, Colorado Division of Wildlife, Colorado Department of Transportation, U.S. Forest Service, U.S. Air Force Academy, F.E. Warren Air Force Base, U.S. Department of Energy, and others have entered into efforts to maintain and restore riparian habitats on private and public lands.

A limited amount of Preble's habitat is within public ownership or easement. The FWS should seek opportunities to protect Preble's habitat through habitat acquisition and/or conservation easements. Any FWS acquisitions or easements will be through willing sellers or cooperators. Acquisitions or easements may focus on protecting riparian habitats occupied or potentially occupied by Preble's, may include all or portions of designated recovery populations, or may add to and expand the size of adjacent designated populations. Acquisitions or easements may form portions of new FWS National Wildlife Refuges, as is the case with the new Rocky Flats National Wildlife Refuge, or may add to existing Refuges.

Conservation Planning

Prior to listing of Preble's, the Colorado Collaborative Planning Process explored the possibility of completing a conservation plan in order to preclude the need to list the subspecies. The Colorado Department of Natural Resources formed the Preble's Steering Committee and the Science Team. The Steering Committee helped coordinate communications, funding, and political and social issues related to Preble's. The Science Team collected information on the biology of the subspecies, identified threats, and began to explore the development of Preble's conservation strategies, including HCPs, from 1998-2000. As of 2002, six counties and several private landowners are developing HCPs. Based upon the science developed through conservation planning for this subspecies, the U.S. Air Force Academy completed the Cooperative Agreement and Conservation and Management Plan for Preble's on the U.S. Air Force Academy grounds (Grunau et al. 1999).

RECOVERY STRATEGIES AND GUIDING PRINCIPLES

The recovery planning approach is based upon the assumption that if certain criteria are met for certain existing populations, Preble's can be delisted. These criteria require that specific populations are maintained in designated habitats distributed throughout the existing range, the populations and habitats are secure from decline due to the threats listed above, the populations are self-sustaining and persistent, a long-term management plan and cooperative agreement is completed, and there is effective public involvement.

When the recovery criteria are met, analysis of the five ESA listing factors (destruction of habitat, overutilization, disease or predation, inadequacy of existing regulatory mechanisms, and other natural or manmade factors affecting the subspecies' persistence) should indicate that protection of the subspecies under the ESA is no longer necessary.

It is believed that there are sufficient populations present today to allow recovery of the subspecies; however, many of these populations face threats to their future survival. Further analysis of the extent and stability of these populations, plus management of the threats to riparian habitat, is needed to achieve recovery.

Throughout the development of this Recovery Plan, the following Recovery Strategies (15) and Guiding Principles (7) for Preble's have been employed:

Recovery Strategies

The decline in the extent and quality of Preble's habitat is considered the main factor threatening the subspecies (Hafner et al. 1998, Shenk 1998). As stated in the rule listing the mouse under the ESA (63 FR 26517), habitat alteration, degradation, loss, and fragmentation resulting from urban development, flood control, water development, agriculture and other human land uses have adversely impacted Preble's populations.

In the development of the Recovery Plan, a number of strategies, approaches, criteria, guidelines, definitions, and processes were selected that are believed to address the threats to the subspecies. When these threats are lessened or eliminated, an analysis of the five factors should show the subspecies is no longer in need of protection under the ESA. A brief explanation of these collective strategies provide the background that guided the development of recovery strategies that appear under Section II of this plan.

1. Recovery Criteria Differences among North Platte, South Platte, and Arkansas Rivers

The known range of Preble's is spread over portions of three major river drainages that differ from each other in criteria for recovery (Section II, Table 1) for the following reasons:

- a. Available information suggests that the extent of the range of Preble's in the North Platte and Arkansas River drainages is very different from the extent of the range in the South Platte River drainage. Two large populations (see Section II) are included within the South Platte River drainage because it incorporates much of the known Preble's range, the drainage is bisected by the metropolis of Denver, and there is no possibility of connection between the large populations.
- b. The level of information on Preble's in the South Platte River and the Arkansas River drainages is much greater, and the range is better defined, than in the North Platte River drainage.
- c. The threats that may affect Preble's populations in the North Platte River are less severe and immediate than the threats affecting populations in the South Platte and Arkansas River drainage.
- d. There are fewer hydrologic units for distribution and assignment of recovery populations in the Arkansas and North Platte River drainages than in the South Platte River drainage.

2. Selection of Hydrologic Unit as the Scale for Recovery

Preble's is a riparian-associated subspecies; therefore, river drainages provide an appropriate geographic scale and unit for addressing their conservation. Species well-distributed across their historic range are less susceptible to extinction and more likely to reach recovery than species confined to a small portion of their range (Noss and Cooperrider 1994, Abbitt and Scott 2001). Distributing populations throughout different drainages reduces the risk that a large portion of the range-wide population will be negatively affected by any particular natural or anthropogenic event at any one time. Spreading the recovery populations across hydrologic units throughout the range of the subspecies also preserves the greatest amount of the remaining genetic variation, and may provide some genetic security to the range-wide population.

Disjunct or peripheral populations are likely to have diverged genetically from central populations due to isolation, genetic drift, adaptation to local environments, or some combination of these factors (Lesica and Allendorf 1995). Therefore, conservation of these outlying populations protects genetic diversity. Data on endangered mammals also shows that many species have declined from the centers of their ranges outward, which also suggests that protecting widely distributed populations is important (Lomolino and Channell 1995).

To address these conservation issues, hydrologic units (corresponding to stream or watershed size) were selected as the basis for determining appropriate locations for the recovery populations. The United States is divided and sub-divided into successively smaller hydrologic units, which are designated by hydrologic unit codes (HUCs) developed by the U.S. Geological Survey. There are 21 two-digit, 222 four-digit, 352 six-digit, and 2,150 eight-digit HUCs found within the United States. In this Plan, the distribution of recovery populations is based upon the 8-digit HUC. Preble's potentially and known occupied HUCs within the North Platte, South Platte and Arkansas River drainages are the geographic unit for designation of recovery populations (Figure 4).

3. Definition of Small, Medium, and Large Recovery Populations

Recovery population sizes were selected to provide a reasonably high probability of persistence for each individual population, as well as for the entire subspecies. The sizes were based upon general conservation biology theory regarding population viability, as well as input from biologists with knowledge of Preble's life history.

Conservation biology literature suggests various numbers of individuals that may be necessary to support long-term viability. The general rule of thumb used in conservation biology has been the 50/500 rule: isolated populations need to have a genetically effective population size of about 50 individuals for short term persistence, and a genetically effective population size of about 500 for long-term survival (Franklin 1980, Soule 1980). The genetically effective population size designates that part of the population in which all individuals have an equal probability of mating and having offspring. In most natural populations the effective population of breeding individuals is often much smaller than the total population size (CSIESA 1995). An effective population size of about 500 individuals translates into a total population size of several times this number (Lande and Barrowclough 1987, Lacy 1995).

Some biologists have questioned the adequacy of the 50/500 rules. Mangel and Tier (1994) indicate that the probability of environmental catastrophes greatly increases the need for larger populations. Lande (1995) estimated the need for a genetically effective population size of approximately 5,000 for long-term persistence, which may translate to a total population size of 10,000 to 20,000 individuals. However, the generalization that a population size in the low thousands is the smallest number of individuals needed for

long-term persistence is widely accepted (Soule 1987, CSIESA 1995) and was used to guide the selection of populations for this Plan. For this Plan, recovery population sizes are defined as follows:

Large populations are self-sustaining, naturally occurring populations that demonstrate June abundance estimates of 2,500 adult Preble's, with no significant negative trend in percent occupancy (as defined in the Population Monitoring Plan) of sampling sites over a minimum of 10 years (see task 1.2, Section II). Larger population sizes provide greater physical diversity of habitats and less vulnerability to natural catastrophic events, while reducing the per unit area management costs. Due to the size of the habitat required to support these populations, large populations should incorporate most of the landscape-level ecological processes associated with the subspecies.

Medium populations are self-sustaining, naturally occurring populations that demonstrate June abundance estimates of 500 to 2,499 adult Preble's, with no significant negative trend in percent occupancy (as defined in the Population Monitoring Plan) of sampling sites over a minimum of 10 years (task 1.2, Section II). Based upon conservation theory (Pimm et al. 1988, Noss and Cooperrider 1994, Meffe and Carroll 1997, Primack 1998), medium populations are at greater risk than large populations, but have a higher probability of persistence than small populations. For maximum protection of this subspecies, most medium populations identified by this plan should be as large as possible.

Small populations are defined as those that demonstrate a continued presence of Preble's within 4.8 km (3 mi) of connected stream habitat over 10 years. Although small populations are expected to be approximately 150 adults, no minimum population size is required for small populations. Small populations are intended to provide geographic distribution throughout the existing range, and are expected to conserve the existing range of genetic diversity in the subspecies.

The numbers identified above for large, medium, and small populations are based on the scientific literature, and represent "state-of-the-art" estimations. It must be recognized that these numbers may be altered in the future if changes are supported by new scientific information.

4. Number and Distribution of Recovery Populations

The distribution of Preble's recovery populations is designed to minimize threats due to the impacts of weather, disease, fragmentation, anthropogenic factors, loss of genetic diversity and other threats to the subspecies. At least one recovery population is required within each HUC within the existing range of the taxon (Section II), except where no Preble's population currently exists and no habitat is present. Three size categories of recovery populations are designated: small, medium and large (see Section 3, above).

To reach recovery, it is essential to have at least the following arrangement of recovery

populations in each major river drainage within the range of Preble's:

- A. North Platte Drainage.** One large and two medium populations in three separate HUCs, as well as three small populations within each of the remaining two HUCs within the North Platte River drainage.
- B. South Platte Drainage.** Two large and three medium populations in five separate HUCs, as well as three small populations within each of the remaining six HUCs within the South Platte River drainage.
- C. Arkansas River Drainage.** One large population, as well as three small populations in each of the remaining two HUCs within the Arkansas River drainage.

All locations with known populations or potential suitable habitat were identified and information on the size of and ownership of the habitat, and its juxtaposition to other populations was considered in designating large, medium, or small populations. If a large recovery population is designated in a particular HUC, no other recovery populations are required in that HUC. HUCs without a designated large recovery population were evaluated for the potential presence of medium populations. If a medium population appeared to be present within the HUC, it was designated as a recovery population. The number of designated medium populations per drainage correlates to the amount of assumed historical habitat within that drainage (Table 1). At least three small populations are required in any HUC that does not have a designated medium or large recovery population, except those HUCs, when adequately surveyed, that are without an existing Preble's population. One medium population may replace three small populations in any HUC; however, in some HUCs only small populations will be achieved.

As with definition of population sizes in strategy 3 above, future new scientific information may support altering the number and distribution of populations necessary for recovery. Therefore, this strategy may need re-evaluation and adaptation to new information. It is important that a recovery plan recognizes the need to incorporate new scientific information as it arises and supports implementation of recovery through adaptive management.

We believe it is important to maintain small populations of Preble's in the HUCs identified. However, we do not know precisely where the range of the Preble's ends. Some of the identified HUCs may actually be found to occur outside the Preble's range or no longer contain Preble's populations. Therefore, if a HUC is found not to contain any currently existing Preble's populations, no recovery populations will be designated for that HUC.

5. Guideline for Estimating Stream Miles Required for Recovery Sites

The associated habitat lengths for the defined size classes of populations were developed with input from researchers with direct knowledge of Preble's populations and habitat. The habitat lengths for a particular category of population size are considered minimum miles of a network of connected streams whose hydrology supports riparian vegetation, provides Preble's habitat, and includes mainstem drainages and tributaries.

In order to provide a guideline for the length of riparian habitat required for large, medium and small populations, an average density of mice per kilometer or mile was needed. Abundances for a specified length of stream have been estimated for the subspecies in Colorado using capture-recapture techniques (Otis et al. 1978, White et al. 1982, White and Burnham 1999). Data were collected in June, providing estimates of population abundance during the post-hibernation period but prior to the inclusion of young-of-the-year.

A known bias in capture-recapture studies from trapping transects or lines is that the traps tend to attract mice from some unknown distance away from the trapping transect (White and Shenk 2001). Furthermore, study areas have unequal lengths of stream reaches trapped. Therefore, simple density estimates of the number of mice divided by stream length is biased high, more so for shorter transects than for longer ones. To remove this bias, a correction factor was developed using radio-telemetry data to estimate the proportion of time radio-collared mice spent within the original trapline once the traps were removed (White and Shenk 2001). Data from six study sites with radio-collared Preble's were used to estimate this correction factor (called " p ") for population estimates from linear traplines or grids. Corrections were applied to all study areas with the function relating (p) to trapline length (L) developed from these data. The mean estimate of mice per mile of stream from 9 study sites, 1998 to 1999, was 53 mice/mi (33 mice/km; standard error = 8 mice/mi or 5 mice/km, sample size = 15 sites), with a range of 6 to 107 mice/mi (4 to 67 mice/km, White and Shenk 2000). The addition of new sites and additional years of data will change the above estimate. Changes in sample sites and the addition of 2 more years of data (2000-2001), for a total sample size of 25 sites, provided a mean of 44 mice/mi (27 mice/km; standard error = 6 mice/mi or 4 mice/km), and a range of 3 to 107 mice/mi (2 to 67 mice/km) (T. Shenk, Colorado Division of Wildlife, unpublished data, R. Schorr, Colorado Natural Heritage Program, unpublished data, C. Meaney, University of Colorado, unpublished data, T. Ryon, Greystone Consultants, unpublished data, M. Bakeman, Ensign Technical Services, unpublished data, and M. Fink, ?unpublished data).

Based upon the current mean density of 44 mice/mi (standard error of 6 mice/mi), the following provides guidelines for estimated stream miles for large and medium recovery populations, and required miles for small populations:

Large populations (June abundances of 2,500 individuals or greater) will likely need a 57-mile (45 to 78 mi or 72 to 126 km) network of connected streams whose hydrology supports riparian vegetation and provides Preble's habitat; this will include the mainstem plus tributaries. This current estimate of miles to maintain 2,500 mice is based upon the mean number of mice that occur per stream mile as estimated from current data (1999-2001), and may not necessarily apply to a specific site due to variations in habitat quality. The intent is to protect enough stream miles of habitat to support the population goal of 2,500 mice.

Medium populations (June abundances of 500 individuals or greater) will likely need an 11-mile (9 to 16 mi or 14 to 26 km) network of connected streams whose hydrology supports riparian vegetation and provides Preble's habitat; this will include the mainstem plus tributaries. This current estimate of miles to maintain 500 mice is based upon the mean number of mice that occur per stream mile as estimated from current data (1999-2001), and may not necessarily apply to a specific site due to variations in habitat quality. For maximum protection of this subspecies, most medium populations should occupy stream habitats that exceed the minimum to support 500 mice.

Small populations (defined as those showing at least continued presence of Preble's) must have at least 4.8 km (3 mi) of connected stream habitat.

It must be emphasized that the recovery goal for large and medium populations is numbers of mice, not numbers of stream miles inhabited. Thus, enough stream miles need to be protected to insure that numeric population goals for large and medium populations can be maintained. Because the figure of 44 mice/mi is a mean for the current Preble's research populations, at least some populations of any particular size are likely to show a lower density and, therefore, would need a larger stretch of habitat in order to meet population recovery goals. Alternatively, some sites may support higher densities of mice than the estimated mean, and could meet population recovery goals with fewer stream miles.

6. Selection of Emergent Preble's for Estimating Population Abundance

Emergent animals are individuals that have survived winter and emerged from hibernation. This segment of the population was selected because it represents the initial number of animals available for reproduction in the current year. Basing conservation strategies on segments of the population present later in the breeding season (July-September) may inflate estimates of the number of individuals that will survive and reproduce. Although the use of emergent mice for sampling purposes does not compensate for all the differences between effective and actual population size, it does help minimize the difference between the two, since all emergent adults are potential breeders and the generation overlap is not as significant as it would be later in the summer.

7. Delineation of Preble's Habitat

Preble's habitat includes riparian systems, the intervening slopes between riparian and upland communities, and upland grasslands (Shenk and Sivert 1999a, Schorr 2001). See Habitat section, Part I, for data on use of uplands adjacent to streams. The width of Preble's habitat is defined as the 100-year flood plain plus 100 m (328 ft) on both sides of the creek. Final habitat delineations for each recovery site will be approved by FWS. However, alternatives to the 100-year flood plain rule will be considered if:

- (1) The area delineated provides all the necessary resources for the mice to nest, breed, find cover, travel, feed, and hibernate; i.e., for long-term survival.
- (2) The area delineated includes the three contiguous geomorphological components used by Preble's: alluvial flood plain, transition slopes, and pertinent uplands (grasslands for feeding and suitable hibernation sites).

Shenk (unpublished data) observed summer movements in excess of 100 m (328 ft), but in most instances Preble's upland habitat use was within 100 m of the 100-year flood plain delineation. Most presumed hibernation sites also were located within 100 m of the 100-year flood plain delineation of the main stream.

8. Self-sustaining Populations as the Measure of "Recovery"

For this Plan, recovery populations are defined as self-sustaining, naturally functioning populations that are not maintained by "stocking" or captive breeding. Translocations and captive breeding may be difficult and can present potentially high risks, and should only be considered as a last resort for maintaining a population or as a means to maintain genetic diversity in FWS-approved site-specific Threat Abatement Management Plans.

Restoration of individuals to previously occupied areas, without an understanding of why the area no longer supports the subspecies, would likely result in resources (e.g., animals, time, and money) being lost to establish reintroduced populations that may meet the same fate as the original population that occupied the area. Furthermore, restocking areas with individuals genetically dissimilar from the individuals in the original population does not protect genetic variability.

9. Selection of Public Lands Over Private Lands as Areas for Preble's Recovery

Selecting public lands as areas for recovery may ensure the implementation of timely and effective land management for the mouse. Where possible, recovery sites are designated on public lands because the likelihood of maintaining stable populations is greater on public lands. Managing land for a common purpose and ensuring consistency in land management practices is easier on larger public lands than on a host of smaller private parcels. Also, designating recovery populations on public property minimizes and/or avoids the potential conflict between private landowners' land management strategies and those strategies recommended for conservation of Preble's; such conflict avoidance may increase support for achieving recovery. Lastly, many public lands have natural resource management strategies in place to conserve the mouse or its habitat.

10. Protect Lands Not Designated as Recovery Sites

Protecting additional habitat for Preble's populations will ensure that the subspecies reaches recovery more quickly. Although a set number of large, medium, and small populations will be designated as recovery populations, a greater chance of achieving recovery is possible by protecting additional populations and habitat where they currently exist. Preble's populations may fluctuate greatly in size, but recovery will only be achieved by ensuring that populations are stable or increasing over many years. Therefore, it may be advantageous to protect additional non-designated recovery populations as insurance in the event that one or more of the designated populations are not stable or increasing. The non-designated yet stable or increasing populations could substitute for recovery populations that are not stable or increasing. Also, by protecting more populations than are necessary for recovery, the threat to the subspecies as a whole from a catastrophic event is minimized. Although several recovery populations may become extirpated due to a catastrophic event such as a flood or hazardous waste spill, recovery may still be uncompromised because there are additional non-designated populations to replace the lost ones.

11. The Need for Additional Research

Previous research on Preble's taxonomy, distribution, demography, ecology, and habitat has been essential in informing the best approaches to its conservation. These descriptive studies have been helpful in understanding the subspecies' biology and suggesting why it uses certain habitats. Research designed to determine cause-and-effect relationships between the mouse and its habitat needs to be conducted. Without an understanding of how habitat factors affect populations, it will be more difficult to manage habitats to ensure the persistence of this subspecies.

Much additional research is still needed, both descriptive and experimental. This includes research on the systematics, range, and distribution of the mouse; identification of management practices that enhance habitat and populations; identification of threats to the persistence and distribution of populations; further refinement of suitable habitat criteria; and development of threat abatement strategies for habitat. Some specific

examples of needed research to facilitate recovery include, but are not limited to, projects identified in Appendix B (Research).

12. Use of Adaptive Management

Adaptive management is a process by which policy decisions are implemented within a framework of scientifically-driven experiments to test predictions and assumptions inherent in management plans. There is still much about Preble's biology and management of habitat that is not well understood. A well-designed adaptive management program may answer some of these questions and be used to modify existing management strategies. Adaptive management should be a strong consideration in the development of the site-specific Threat Abatement Management Plans.

13. Single Species Focus

Due to time constraints, the development of this plan focused on a single species strategy for recovery of Preble's within the North Platte, South Platte and Arkansas River drainages of Wyoming and Colorado. Although the actions recommended by the Plan are focused on Preble's, the protection of populations and habitat for this subspecies may benefit other listed and declining species within riparian habitats of Wyoming and Colorado. At some time in the future, a multi-species plan for declining Wyoming-Colorado Front Range species may be considered.

14. Genetic Management

The goal of genetic management within this Plan is to preserve and conserve the range of unique ecological and behavioral characteristics of the subspecies that are presumed to exist on a population by population basis. Work completed to date on mitochondrial DNA (Riggs et al. 1997) indicated that Preble's is a distinct genetic "group." Additional research needs to be conducted on the molecular genetics (mitochondrial and nuclear DNA) of the species and subspecies of jumping mice. This research will improve the understanding of the genetic differences between species and subspecies of jumping mice, variation between isolated populations, any evidence of interbreeding between species, populations with the most genetic diversity, and those populations experiencing inbreeding problems. The Team may consider completing a genetics management plan in the future, based upon information obtained through the completion of genetic research proposed by this Plan.

15. Delisting Process

Section 4 of the ESA governs the listing, delisting, and reclassification of species, the designation of critical habitat, and recovery planning. Regulations implementing listing, delisting, reclassification, and critical habitat designation are codified at 50 CFR 424.

The process of delisting a species (or subspecies), is essentially the same as that of listing: a proposed rule describing the justification for the action is published in the Federal Register, a public comment period is opened (including public hearings if requested), and within 1 year of the proposal, either a final rule delisting the species or a notice withdrawing the proposed delisting is published in the Federal Register.

In considering whether to delist a species, the same five factors considered in the listing process are evaluated:

1. The presence or threatened destruction, modification, or curtailment of the species' habitat or range.
2. Overutilization for commercial, recreational, scientific, or educational purposes.
3. Disease or predation.
4. The inadequacy of existing regulatory mechanisms.
5. Other natural or manmade factors affecting the species' continued existence.

It is believed that there are currently sufficient Preble's populations that should they persist into the future, the subspecies' survival will be assured. However, there are substantial threats to many of the populations that, if left unabated, may cause their decline or extirpation in the future. Therefore, this recovery plan focuses on designating populations of sufficient size, number and distribution that will need to be managed to into the future and protected from threats. The current number, size, and distribution of Preble's population that currently exist are believed to meet recovery criteria

The abatement of threats relating to criteria one through four, identified within Part II of this Recovery Plan, are believed to be adequate for delisting Preble's. When these threats are lessened or eliminated for each recovery population, an analysis of the above factors should show the subspecies is no longer in need of protection under the ESA.

Guiding Principles

The following principles provided guidance to the recovery team during development of this plan:

1. Management by River Drainage

Because Preble's populations are physically separated in three different drainages, and the threats to the recovery populations differ in type and intensity between these drainages, Preble's will be most effectively managed by considering each of the following drainages separately:

1. North Platte River (Wyoming)
2. South Platte River (small area in Wyoming, but mainly Colorado)
3. Arkansas River (Colorado)

2. Research

Many important aspects of Preble's biology and management are not known. Thus, continuing research in conjunction with adaptive management is crucial.

3. Monitoring and Adaptive Management

Designated Preble's recovery populations and habitats will be monitored for a period of time to be determined by the approved Population and Habitat Monitoring Protocols. The results of such monitoring efforts and their implications should be evaluated within an adaptive management framework, and the management goals should be readjusted accordingly. This process should continue until management efforts allow the achievement of self-sustaining populations. Unless scientific evidence points to the contrary, the recommended initial management strategy for each area occupied by Preble's is to continue the existing land uses at current levels.

4. Local Involvement

The plan encourages all aspects of local involvement, particularly by those entities that own or manage lands on which Preble's populations may exist. Examples of entities that should be involved with the recovery of Preble's include State wildlife management agencies, State park and natural resource agencies, State land boards, county and city open space programs, public water boards, water conservation districts, private land owners, and other elements of State, county, and local governments.

5. Cooperative Management

Numerous agencies, land owners, and organizations (listed above) have responsibility for lands that contain Preble's habitat. These entities need to continue to be involved in cooperative recovery efforts, and cooperative management among these should be fostered wherever possible.

6. Incentives

Incentives should be developed to encourage participation, build partnerships, and foster cooperation with recovery efforts. These can include Preble's recovery funds, tax incentives at the Federal, State, or county level to encourage active conservation measures on private lands, or the establishment of an award/reward system for participation in recovery programs.

7. Education Programs

Education programs that focus on Preble's populations and habitat protection can benefit

recovery objectives. Education programs are encouraged, and should focus on the loss of habitat near urban centers.

PART II: RECOVERY

Objective

The objective of this recovery plan is to delist the Preble's.

Summary of Four Criteria for Delisting of Preble's

Preble's will be considered recovered and eligible for delisting when it is demonstrated that:

1. Four large and five medium wild, self-sustaining populations of Preble's exist that are widely distributed across the North Platte, South Platte, and Arkansas River drainages; and three small populations exist in each sub-drainage (HUC) that contains suitable Preble's habitat and is not occupied by a large or medium population (Figure 5, Table 1).

Large populations are defined as those that demonstrate June abundance estimates of at least 2,500 adult Preble's, with no significant negative trend in percent occupancy (as defined in the Population Monitoring Plan) of sampling sites over a minimum of 10 years (see Task 1.2.1).

Medium populations are those that demonstrate June abundance estimates of 500 to 2,499 adult Preble's, with no significant negative trend in percent occupancy (as defined in the Population Monitoring Plan) of sampling sites over a minimum of 10 years (see Task 1.2.1).

Small populations must show at least continued presence of Preble's over a minimum of 10 years (as defined in the Population Monitoring Plan), and must have at least 3 miles of connected stream habitat. One medium population may replace three small populations in any HUC.

Note: Population monitoring will be conducted according to the Recovery Team's accepted Preble's Population Monitoring Plan (Task 1.2.1).

The recovery populations will be distributed among the following river drainages:

- A. **North Platte Drainage.** One large and two medium populations in three separate HUCs, as well as three small populations within each of the remaining two HUCs within the North Platte River drainage.
- B. **South Platte Drainage.** Two large and three medium populations in five separate HUCs, as well as three small populations within each of the remaining six HUCs within the South Platte River drainage.

- C. **Arkansas River Drainage.** One large population, as well as three small populations in each of the remaining two HUCs within the Arkansas River drainage.

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Information is currently lacking on the presence of existing Preble's populations and suitable habitat in some HUCs. They have been included in these criteria on the presumption that at least a small population occurs there. HUCs that are determined upon further surveying to be without an existing Preble's population will be removed from these criteria.

2. Sufficient habitat of each designated Preble's recovery population is protected and managed to sustain the subspecies (see Task 2).
3. Threats to Preble's populations are eliminated, minimized, or reduced in accordance with site-specific Threat Abatement Management Plans to ensure the conservation and survival of the recovery populations.
4. A long-term adaptive management plan and cooperative agreement for the management of Preble's and the habitat upon which it depends is completed with the goal of maintaining the designated recovery populations at self-sustaining levels after delisting (Task 4.0).

Distribution of Designated Recovery Populations within River Drainages

Table 1 lists the specific large and medium populations that have been designated as necessary for recovery in the North Platte, South Platte, and Arkansas River drainages.

Table 1. Locations of Designated Recovery Populations, 2002.

MAJOR DRAINAGE	8-DIGIT HUC	GENERAL LOCATION
<i>North Platte</i>		
1 Large	Lower Laramie	Chugwater Creek
2 Medium	Horse	Horse Creek
	Glendo Reservoir	Cottonwood Creek
3 Small	Middle North Plate	To be determined
3 Small	Middle North Platte/Scottsbluff	To be determined

<i>South Platte</i>		
2 Large	Poudre	North Fork Poudre River
	Upper South Platte	West Plum Creek
3 Medium	Middle South Platte	Cherry Creek
	Big Thompson	Buckhorn Creek
	North Saint Vrain	South Boulder Creek
18 Small	Crow Creek	To be determined
	Crow Creek	To be determined
	Crow Creek	To be determined
	Lone Tree	To be determined
	Lone Tree	To be determined
	Lone Tree	To be determined
	Upper Lodgepole	Middle Lodgepole Creek
	Upper Lodgepole	Upper Middle Lodgepole Creek
	Upper Lodgepole	To be determined
	Clear Creek	To be determined
	Clear Creek	To be determined
	Clear Creek	To be determined

	Kiowa	To be determined
	Kiowa	To be determined
	Kiowa	To be determined
	Bijou	To be determined
	Bijou	To be determined
	Bijou	To be determined
Arkansas		
1 Large	Fountain	Monument Creek/Air Force Academy
0 Medium	N/A	N/A
6 Small	Chico	To be determined
	Chico	To be determined
	Chico	To be determined
	Big Sandy	To be determined
	Big Sandy	To be determined
	Big Sandy	To be determined

Note: HUCs listed as “to be determined” have the potential to hold Preble's populations but have not been confirmed.

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STEP DOWN OUTLINE AND TIMELINES

TASK #	DESCRIPTION	TIMELINE
1.0 Wild, Self-Sustaining Populations		
	1.1 <u>Complete selection, confirmation, and delineation of designated Preble's recovery populations.</u>	
1.1.1	Maintain a data base of all Preble's locations.	Start, year 1
1.1.2	Survey populations and assess size and extent.	Start, year 1
1.1.3	Designate remaining recovery population sites.	End, year
1.1.4	Notify property owners within designated recovery sites.	Start, year 1
1.1.5	Delineate all recovery population sites.	Start year 1
	1.2 <u>Monitor all designated Preble's recovery populations.</u>	
1.2.1	Develop a peer-reviewed Population Monitoring Plan.	Immediate
1.2.2	Monitor designated large and medium recovery populations.	After delineation

1.2.3	Monitor designated small recovery populations.	After delineation
<p>1.3 <u>Conduct population-related research.</u></p>		
1.3.1	Conduct research on Preble's taxonomy	Ongoing
1.3.2	Conduct research on distribution of Preble's populations.	Ongoing
1.3.3	Design and conduct studies on Preble's demography.	Ongoing
1.3.4	Conduct research on the ecology of Preble's.	Ongoing
1.3.5	Conduct threat abatement research.	Ongoing
2.0 Habitat		
<p>2.1 <u>Map the length and width of delineated Preble's habitat.</u></p>		
<p>2.2 <u>Monitor habitat of all designated recovery populations.</u></p>		
2.2.1	Develop a peer-reviewed Habitat Monitoring Plan.	Immediate
2.2.2	Monitor habitat of recover populations.	After delineation

2.3 <u>Conduct research on Preble's habitat.</u>		
2.3.1	Identify habitat used by Preble's.	Ongoing
2.3.2	Conduct research on effects of habitat features.	Ongoing
2.3.3	Evaluate effects of habitat management.	Ongoing
3.0 Threat Abatement		
3.1 <u>Abate threats to designated recovery populations.</u>		
3.2 <u>Identify and prioritize threats to recovery populations.</u>		
3.3 <u>Develop and implement Threat Abatement Management Plans.</u>		
3.3.1	Maintain the effects of ecological processes.	Immediate
3.3.2	Develop and implement abatement strategies for multiple sites.	Immediate
3.4 <u>Protect and conserve non-designated recovery populations.</u>		
3.4.1	Protect and manage all populations on Federal lands.	Immediate

3.4.2	Protect and conserve non-designated populations on public land.	Immediate
3.4.3	Protect and conserve non-designated populations on private lands.	Immediate
3.5 <i><u>Develop and provide economic and social incentives.</u></i>		
3.5.1	Encourage recovery funding.	Immediate

II. STEP DOWN NARRATIVE

1.0 Population Management

1.1 Complete Selection, Confirmation and Delineation of Designated Large, Medium, and Small Preble's Recovery Populations. Federally owned lands were the first designated as recovery sites for Preble's. Other lands in public or conservation ownership determined, in coordination with the appropriate land managing agency to be suitable for a recovery population, will also be given priority consideration. All required large and medium recovery populations within the existing range of Preble's in the North Platte, South Platte and Arkansas River drainages have been designated (Table 1). However, some small recovery populations must still be designated with local stakeholder involvement (Task 1.1.3). The boundaries of all recovery populations should be delineated within 3 years of the approval of the recovery plan.

1.1.1 Maintain a Database and Map of All Known Preble's Locations. A preliminary map of known Preble's locations has been developed, but will need to be updated as additional information on populations becomes available. The FWS will maintain and update the database of Preble's locations in Colorado and Wyoming. Results of all trapping and other documentation of Preble's occurrence will be reported annually as required in permits provided to surveyors by the Service under Section 10(a)(1)(A) of the Act. Annual reporting is a standard requirement of Section 10 (a)(1)(A) permits. Maps and information on Preble's populations will be accessible on the FWS Region 6 web-site <http://mountain-prairie.fws.gov>.

1.1.2 Survey Populations and Assess Their Size and Extent. Surveys of potential small recovery sites are needed to determine Preble's presence, approximate population size, and distribution. This information is necessary to be able to finalize Preble's recovery population designations.

Additional surveys to determine presence and distribution of Preble's are needed in the following HUCs to determine if Preble's populations are present:

- Chico and Big Sandy HUCs of the Arkansas drainage;
- Bijou, Kiowa, Lone Tree, Crow, Upper Lodgepole and Clear Creek HUCs in the South Platte drainage; and
- Middle N. Platte River-Casper, Glendo Reservoir, and Middle N. Platte River
- Scottsbluff HUCs in the North Platte drainage.

Within other HUCs, additional surveys may prove useful for providing options during the designation of recovery populations (Task 1.1.3) and when recovery populations are delineated. (Task 1.1.5). Where appropriate, newly discovered populations can be nominated as replacement or alternative recovery populations, as long as they meet the Recovery Criteria.

1.1.3 Designate Remaining Recovery Population Sites.

Local governments and/or Site Conservation Teams (Task 5.3) have the opportunity to complete designation of three small recovery populations in each of the following HUCs within 3 years: Chico and Big Sandy HUCs of the Arkansas River drainage; Bijou, Kiowa, Clear Creek, Crow, Lone Tree, and Upper Lodgepole HUCs within the South Platte; and Middle North Platte-Casper, Middle North Platte-Scottsbluff within the North Platte (Table 1). If a HUC is found to support only one or two small populations, then those populations will be designated and designation of additional populations will not be required in that HUC. If a HUC is found not to contain any remaining Preble's populations, no populations will be designated for that HUC.

If Preble's are present within a HUC, and recovery populations are not designated within 3 years of the acceptance of this plan, the FWS will designate the remaining recovery populations. If new populations are discovered, alterations in designations within a HUC, can be made as appropriate with FWS approval.

1.1.4 Notify Property Owners. Information on location of recovery populations will be provided to private landowners. All landowners will be notified that their property may be within the boundaries of a designated Preble's recovery site. In order to effectively monitor and manage designated recovery populations and habitat, landowner buy-in is necessary. The FWS, with the assistance of the Site Conservation Teams and local governments, will notify private land owners prior to recovery site delineation.

1.1.5 Delineate All Recovery Population Sites. Local governments and/or Site Conservation Teams have the opportunity to delineate the boundaries of recovery populations (large, medium, and small) within 3 years of acceptance of this recovery plan. For this plan, the process of delineation will involve mapping the boundaries of the population sites. Final delineations will be approved by the FWS. If site boundaries are not delineated within 3 years of the acceptance of this plan, the FWS will coordinate with local governments to complete the delineation within one year taking into account local conservation efforts.

Ditches may serve as connectors within recovery sites. Designated recovery population sites can include ditches, or connecting ditches if affected landowners and affected water rights holders agree to the inclusion and management of the ditches for Preble's recovery.

1.2 Monitor All Designated Preble's Recovery Populations. Monitoring of designated recovery populations is needed to determine their existing size and trend according to the Preble's Population Monitoring Plan. Other monitoring methodologies may be considered in the future, if they are found by the FWS to be scientifically valid in determining

population trend. If positive or negative trends are documented, site-specific Threat Abatement Plans (Task 3.3) can be adapted to promote recovery. Results of the monitoring will be provided to the FWS and/or the Recovery Team, and made available to the public.

1.2.1 Develop a Peer-Reviewed Preble's Population Monitoring Plan to Estimate Population Trends in Each Designated Recovery Site. A Population Monitoring Plan was developed by experts in population monitoring to assess current population status, and to initiate monitoring of population trends. This Plan may be modified or updated as new scientific information becomes available. The Population Monitoring Plan is available on the FWS website at <http://mountain-prairie.fws.gov>. This task has been completed.

1.2.2 Monitor Designated Large and Medium Recovery Populations. Designated large and medium recovery populations will be monitored for June (pre-breeding) population sizes and trends according to the Population Monitoring Plan. Monitoring needs to begin within 1 year of delineation of the Preble's recovery population. For each of the designated recovery populations, monitoring results will be used in the development and implementation of Threat Abatement Plans using adaptive management (Task 3.3).

1.2.3 Monitor Designated Small Recovery Populations. All designated small recovery populations will be monitored at a minimum for presence/absence according to the Population Monitoring Plan. Monitoring needs to begin within 1 year of delineation of the Preble's recovery population. Results of the monitoring will be used in the development and implementation of Threat Abatement Plans using adaptive management (Task 3.3).

1.3 Conduct Research on the Taxonomy, Distribution, Demography, and Ecology of Preble's Populations. Because relatively little is known about Preble's, research is needed on the taxonomy, distribution, demography, and ecology of the subspecies. The primary goals of this research program should be to enhance understanding of Preble's biology and to assess how land management practices affect Preble's population viability. Information gained from these studies will facilitate recovery by improving the ability to identify the distribution and range of Preble's, to identify management practices that enhance Preble's populations, and to identify and abate threats to the persistence and distribution of populations. See Appendix B for additional research detail.

1.3.1 Conduct Research on Preble's Taxonomy. Develop and evaluate morphological, genetic and systematic techniques to identify Preble's and its relationships to other taxa. This will enable clarification of range, distribution and population genetics.

1.3.2 Conduct Research on Distribution of Preble's Populations. Additional research is needed to further identify the distribution of Preble's. This will provide the

information necessary to maintain populations throughout the range, and identify ecological limits for the subspecies.

- 1.3.3 Design and Conduct Studies to Provide Information on the Demography of Preble's.** Information on demographic parameters such as survival, reproduction, and movement patterns, as well as trends in these parameters, is needed for future management. Research could be conducted at any of the designated recovery sites; however, to facilitate gathering of long-term information, priority should be given to continuing or building on past research in the following areas: Maytag Property, U.S. Air Force Academy, Rocky Flats (Rock, Walnut, and Woman Creeks), South Boulder Creek, Woodhouse Property, Dirty Woman Creek (El Paso County), and East Plum Creek (Castle Rock).
- 1.3.4 Conduct Research on the Ecology of Preble's Populations.** Design and conduct studies to identify the important ecological factors affecting Preble's populations. For example, research interaction between Preble's and other native and non-native small mammals is needed.
- 1.3.5 Conduct Research to Identify and Assess Threats and Threat Abatement Strategies to Preble's Populations.** Evaluate effects of population management techniques and threat abatement strategies on the status, distribution, and demography of Preble's.

2.0 Habitat

2.1 Map the Habitat for Delineated Preble's Recovery Populations.

It is essential that both the length and width of the habitat in each designated recovery population be mapped to ensure that sufficient Preble's habitat is conserved and managed along the length and width of the stream to provide the necessary habitat components for the subspecies' survival in each recovery population. The length of the habitat will be set by the population delineation (Task 1.1.5). The width of habitat will be defined as the 100-year flood plain plus 100 meters on both sides. Alternatives to the 100-year flood plain rule will be considered, if the area provides all the necessary resources for Preble's to nest, breed, have cover, travel, feed, and hibernate. Final habitat delineations must be determined by the FWS as sufficient to meet recovery criteria.

All Preble's occupied habitat on Federal lands, whether associated with a designated recovery population or not, will be mapped. A preliminary map of the designated large, medium and small recovery populations has been developed, but it will need to be updated as delineation of recovery populations (Task 1.1.5) and mapping of habitat occurs. The FWS will maintain and update this database. Maps and other information on Preble's populations will be accessible through the FWS web-site. Habitat mapping will be completed by and/or coordinated with government land owners, local governments and/or Site Conservation Teams/HCP groups, and willing private landowners.

2.2 Monitor Habitat of All Designated Preble's Recovery Populations. All designated recovery populations will be monitored to determine trends in habitat quantity and quality, according to a Preble's Habitat Monitoring Plan. Other monitoring methodologies may be considered in the future, if they are found by the FWS to be scientifically valid in determining trends in habitat quality and quantity. If positive or negative trends are documented, site-specific Threat Abatement Management Plans (Task 3.3) can be adapted to promote recovery. Results of the monitoring will be kept by the FWS, presented at Recovery Team meetings, and made available to the public.

2.2.1 Develop a Peer Reviewed Preble's Habitat Monitoring Plan. A Habitat Monitoring Plan is being developed by experts in Preble's habitat and will need to be applied to monitor the habitat of each designated recovery population. Development of this Preble's Habitat Monitoring Plan will provide a means to assess current habitat conditions and monitor habitat trends.

2.2.2 Monitor Habitat of All Recovery Population Sites. Monitoring needs to begin within 1 year of delineation of the designated Preble's recovery population sites, and be consistent with the Habitat Monitoring Plan. For each of the designated recovery populations, monitoring results will be used in the development and implementation of a Threat Abatement Plan using adaptive management (Task 3.3).

2.3 Conduct Research on Preble's Habitat. Research is needed to enhance understanding of Preble's habitat and how land management practices affect Preble's population viability. Information gained from this research will facilitate recovery by improving the ability to define and quantify Preble's habitat, identify management practices that enhance Preble's habitat, and develop threat abatement management strategies for Preble's habitat. See Research Appendix B for additional research detail.

2.3.1 Identify and Describe Habitat Used for Nesting, Breeding, Cover, Travel, Feeding, Dispersal, and Hibernation. Site-specific and landscape habitat features include, but are not limited to--stream reach, vegetation composition and structure, landscape context (e.g., connectivity with other potential sites, topography, geomorphology), spatial relationship between these features, soil type, extent of habitat, elevation, hydrology (water quality and quantity), and distance to nearest open water.

2.3.2 Design and Conduct Studies to Provide Information on the Effects of Habitat Features (Listed Above) on the Demography of Preble's. Demographic parameters include density, over-summer survival and hibernation survival, recruitment, reproduction, population structure (age and sex ratios), immigration and emigration rates.

2.3.3 Evaluate Habitat Management Techniques. Evaluate effects of habitat management techniques and threat abatement strategies on maintenance and enhancement of habitat and on distribution and demography of Preble's populations.

3.0 Threat Abatement.

3.1 Abate Threats to Designated Recovery Populations. Threats are sources of stress to populations, species, ecological communities, or ecosystems. Threats may be direct or indirect; direct threats may include any source of stress within the habitat while indirect threats may include any activity adjacent to habitat but having an effect on that habitat. Threats need to be eliminated, minimized, or reduced as necessary to achieve population and habitat recovery criteria. Actions necessary to accomplish recovery through abatement of threats will be addressed in the Threat Abatement Plans developed for each designated recovery population. Threat Abatement Plans should be developed and implemented by Preble's Site Conservation Teams, in coordination with the Governance Committee.

To facilitate threat abatement, the Governance Committee (Task 5.2) should provide political support for implementation of this Plan through developing agreements, evaluating progress, establishing funding priorities and expediting communication and cooperation between the private and public sectors. At the local level, the Site Conservation Team (Task 5.3) should be tailored to each individual recovery site, and should include a wide range of stakeholders, private landowners and agencies.

3.2 Identify and Prioritize Threats to Recovery Populations. For each designated recovery site, Preble's Site Conservation Teams (Task 5.3) need to first identify threats, then eliminate, minimize or reduce the identified threats. Site-specific threats include any or all of the five listing factors from the ESA. Examples of potential threats within these five listing factors are listed in Section 1, Reasons for Listing and Threats to Recovery. Threats listed below are adapted from the Conservation Planning Handbook for the Preble's Meadow Jumping Mouse (Pague and Grunau 2000), and also appear in more detail in Section I. Threats are not ranked in any order of priority, and some threats may increase with the level of intensity. (County wants priorities developed by Collaborative Planning Process to be used Bruce checking on this?).

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

- ▶ Habitat conversion, habitat destruction, and habitat fragmentation through housing,

- commercial, recreational, and industrial construction.
- ▶ Hydrology impairments and ground water flow alterations.
- ▶ Fragmentation of habitat and corridors.
- ▶ Rock and sand extraction.
- ▶ Bank stabilization and channelizing of waterways.
- ▶ Farming and ranching operations.
- ▶ Travel corridor maintenance, construction, and accidents.
- ▶ Noxious weeds.
- ▶ Recreational trail development and use.
- ▶ Utilities and ditch construction and maintenance.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

Factor C. Disease or Predation.

- ▶ Increased predation or competition by exotic species or enhanced natives.
- ▶ Disease.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

- ▶ State, Federal, and local statutes and protective measures.

Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence.

- ▶ Pesticide and herbicide use.
- ▶ Fire.
- ▶ Exotic animals.
- ▶ Water quality.
- ▶ Alteration of vegetation succession.
- ▶ Stochastic demographic, genetic, and environmental events.

3.3 Develop and Implement Comprehensive, Site-Specific Threat Abatement

Management Plans. For each designated recovery population, a Site Conservation Team (Task 5.3) needs to develop and implement a site-specific Threat Abatement Management Plan to protect, manage and monitor the population and habitat. The Preble's Habitat and Population Monitoring Plans will be used for this purpose. Each Threat Abatement Plan will address the threats specific to that site (Task 3.2), and may be modified as necessary based upon research and adaptive management. If current management practices at a recovery site do not appear to pose threats that would preclude meeting recovery criteria on that site, these practices can be maintained.

Threat Abatement Management Plans will be designed to eliminate, minimize, or reduce those threats to levels that will achieve and maintain population and habitat criteria, and sustain Preble's at the site.

Threat Abatement Management Plans should be completed within 1 year of delineation of the recovery population boundaries, and submitted for review and approval by the Recovery Team and FWS. The Threat Abatement Plans will be incorporated into the Long-Term Management Plan (Recovery Criteria 4, Task 4.1) at delisting.

3.3.1 Maintain the Effects of Ecological Processes That Support Preble's and its Habitat. Preble's habitat has developed in a dynamic system that includes seasonal flooding, periodic drought, occasional fire, and a complex array of other environmental factors. Preble's habitat may best be maintained by ensuring that the natural processes that have maintained the habitat and populations of the designated recovery sites be allowed to continue. However, where this is not possible, alternative management actions (such as controlled burns) may be necessary to simulate the effects of natural processes.

3.3.2 Develop and Implement Threat Abatement Strategies That Benefit Multiple Recovery Sites. Coordination between the Recovery Team and the Site Conservation Team(s) should allow assessment of threats common to multiple recovery sites and facilitate development of cross-site strategies. Examples of cross-site strategies could including grazing recommendations, utility easement management, regional HCP initiatives, and funding opportunities. These strategies also may be applied to non-designated population sites to promote conservation of the subspecies. Development of regional HCPs should include specific management strategies that will not preclude recovery of the subspecies, or have net negative impact to Preble's habitat within designated recovery sites. All HCPs should be consistent with the goals and activities of site-specific Threat Abatement Management Plans developed for designated recovery populations (Task 3.3).

3.4 Protect and Conserve Non-designated Preble's Populations and Their Associated Habitats as Part of a Threat Abatement and Conservation Reserve for this Subspecies. Protection of non-designated populations preserve the genetic diversity across the range of the subspecies, provide research sites, and provide replacement or alternative recovery populations if unforeseen problems develop within designated recovery sites.

3.4.1 Protect Non-Designated Populations on Federal Lands. Protect and manage all non-designated Preble's populations and their habitat on Federal lands, and utilize Federal Programs to support conservation and recovery of Preble's. Section 7 of the ESA mandates that all Federal agencies shall utilize their authorities to conserve listed species on their lands. To implement Preble's recovery, Federal agencies are responsible to protect all Preble's populations on Federal lands, abate threats, and where biologically appropriate, restore and/or improve habitat on their lands to enhance Preble's populations. These include, but are not limited to--lands under the jurisdiction of the Department of Energy, Department of Defense (Air Force and Corp of Engineers), Department of Agriculture, and the Department of Interior.

Some Federal sites, including Rocky Flats (Rock, Walnut and Woman Creeks), Warren AFB, and the Air Force Academy, have a history of Preble's research and should continue to be used for research in order to facilitate gathering long-term information on Preble's habitat and ecology. (See Tasks 1.3 & 2.3). Those research sites not designated as Preble's recovery populations may become substitute recovery populations if they meet recovery site criteria. In the event that a designated site does not meet recovery criteria, research sites may be substituted, if approved by the FWS.

Preble's conservation is a high priority of the newly established Rocky Flats National Wildlife Refuge. (Add discussion of CCP or anything? Check with Refuges)

A variety of Federal agencies (Department of Transportation, Environmental Protection Agency (EPA), Corps of Engineers (COE), Department of Agriculture, FWS, Natural Resources Conservation Service (NRCS), and others) conduct, fund, or permit activities on non-Federal land that may benefit or adversely impact Preble's. Each Federal agency should review its activities and authorities, and ensure that they support recovery objectives. While special emphasis should be placed on designated recovery populations, the same principles apply to any area supporting Preble's populations. Need specific tasks for specific agency actions?

3.4.2 Protect and Conserve Non-designated Preble's Populations and Their Habitat on State and Local Public Lands and by local public agencies. State agencies such as, but not limited to, the Colorado Division of Wildlife, Colorado Division of Parks and Outdoor Recreation, the Colorado State Land Board, Wyoming Game and Fish, Wyoming State Parks and Historic Sites, Wyoming Land Board, and county and municipality open space programs all manage lands known to support Preble's. These agencies have authorities that can be used to identify and protect non-designated Preble's populations, to abate threats, seek funding, and where biologically appropriate, to restore and/or improve Preble's habitat on these lands. Cooperative agreements or other appropriate mechanisms should be developed to protect and conserve Preble's and its habitat on these lands.

Because water management actions can affect Preble's habitat, public water boards, water conservation districts and other water management entities should evaluate how current management might affect Preble's, determine what actions should be taken to minimize impacts or improve conditions, and implement actions to support Preble's recovery.

3.4.3 Protect and Conserve Non-Designated Preble's Populations and Their Habitat on Private Lands. Private land owners are encouraged to protect and conserve Preble's on their land, and should be aware of the protections and prohibitions on take of listed species provided by the ESA. Until Preble's is delisted, Section 9 of the ESA prohibits the take of Preble's resulting from actions undertaken on all lands, including lands associated with designated and non-designated Preble's populations. Activities conducted on private lands that result in take of Preble's could include, but are not limited to, actions that modify habitat and reduce Preble's populations. However, the FWS has adopted a 4(d) rule (October 1, 2002) that removes prohibitions on take of Preble's resulting from certain activities. (cite in lit). In addition, with a Section 10 permit from the FWS, a private landowner may incidentally take Preble's and alter or remove habitat through development of a HCP or in joining in a HCP developed by the State or local community. For additional information contact the Colorado FWS Field Office.

3.5 Develop and Provide Incentives to Abate Threats and Conserve Preble's and its Habitat. Encourage the development of Federal, State, and county incentive programs for conservation of the subspecies, and its habitat for private and public land owners. Build partnerships and collaborative processes among the public and private entities to leverage resources and achieve economies of scale.

3.5.1 Encourage the Development of Preble's Recovery Funds. These funds may be provided by Federal, State, and local governments, as well as private sources. All federal, state, and local agencies should investigate methods of funding implementation of Preble's recovery.

3.5.2 Support Efforts to Create Tax Incentives on Federal, State, and/or County Levels to Encourage Active Conservation Measures to Recover the Subspecies. Tax incentives could recognize possible loss of use or value of private property caused by designation and requirements of a Preble's Recovery Site Plan. Examples:

- Federal tax benefits to land owners of designated recovery sites.
- Tax credits of up to 100% for expenditures for furthering the recovery of Preble's.
- Provide for a property tax credit for private property or a portion thereof that is managed to promote recovery of Preble's.
- Deductions from the gross estate of a decedent in an amount equal to the value of real property subject to designation as a recovery site.

3.5.3 Support Efforts to Establish a System of Awards and Rewards for Participation in Voluntary and Cooperative Preble's Recovery Site Designation, Monitoring and Conservation. Examples of award and reward programs may include:

- Encourage the development of Federal, State, and/or county grants for Preble's Recovery Sites.
- Provide Transfer of Development Rights that are equivalent to the current county zoning.

- Streamline, reduce, or eliminate regulations and administrative paperwork to expedite conservation and management of recovery sites. Like what?

3.6. Conduct Research to Evaluate Effects of Threat Abatement Strategies. Evaluate impacts of threats on the status, distribution, and demography of Preble's populations, as identified in 3.2 and section 1, and the effectiveness of threat abatement strategies. Information gained from threat abatement research will facilitate recovery by identifying and quantifying threats, and will help in developing threat abatement management strategies. See Research Appendix, for additional research detail.

4.0 Continued Conservation of Preble's Following Delisting.

4.1 Develop a Long-term Management Plan To Be Implemented after Delisting. As required in Recovery Criteria #4, a long-term management plan will need to be prepared to ensure that self-sustaining recovery populations are maintained. This plan should incorporate information obtained during implementation of recovery tasks and identify actions to be implemented after the subspecies is delisted. This management plan will be developed in cooperation with the Recovery Team, Site Conservation Teams, the Governance Committee, agencies, and other interested parties. Records will be maintained on recovery activities to provide pertinent information in the development of the long-term management plan, (Task 5.4).

The management plan should ensure that adequate regulatory mechanisms and management programs remain in existence after delisting, such that populations of Preble's are maintained into the future. The long-term management plan must be reviewed and approved by the FWS.

The plan will need to provide pertinent biological and management information for use in maintaining Preble's populations into the future and identify how populations will continue to be monitored and what conditions may warrant relisting of the subspecies. The plan also should address future interagency cooperation and agency responsibilities and cooperative agreements established in Task 4.2.

The plan should be developed and approved by all parties with jurisdiction over Preble's recovery populations before the proposed delisting. The delisting plan should contain at least the following information:

- I. Biology
 - A. Systematics
 - 1. Population genetics
 - 2. Taxonomy
 - B. Ecology
 - 1. Distribution.
 - 2. Habitat use

3. Food preferences
4. Demography.
5. Hibernation.
6. Behavior.
7. Interactions with other species

II. Present Status of Preble's

- A. Brief history of recovery and recovery strategies.
- B. List of current Preble's populations.
- C. Population and habitat trend monitoring data.
- D. Status of Threat Abatement Plans.

III. Analysis of Listing Factors, 1998 to Present (Delisting)

- A. The presence or threatened destruction, modification, or curtailment of the species' habitat or range.
- B. Overutilization for commercial, recreational, scientific, or educational purposes.
- C. Disease or predation.
- D. The inadequacy of existing regulatory mechanisms.
- E. Other natural or manmade factors affecting the species' existence.

IV. Future Management Goals and Objectives

- A. Conservation Management.
 1. Future population, habitat and threat abatement objectives.
 2. Population and habitat monitoring.
 3. Connection of Isolated populations.
 4. Genetic monitoring.
 5. Research.

V. Implementation Strategies

- A. List of future Preble's conservation activities, year to be complete, and responsible parties.

- 4.2 Prepare a Cooperative Agreement for Implementation of the Long-Term Management Plan.** A Cooperative Agreement between the Service and major conservation partners to implement the long term management plan will be needed to define the role of the management parties in maintaining populations of Preble's. The cooperative agreement can incorporate smaller cooperative agreements that may have been developed for individual recovery populations, and needs to be approved by the FWS prior to delisting.

5.0. Organization and Communication Strategies.

The formulation of the Governance Committee and Site Conservation Teams will help guide and implement this Plan at regional and local levels.

- 5.1 Maintain a Preble's Recovery Team.** A Recovery Team and/or recovery workgroups should be maintained to assist in implementation of this Plan. Following the FWS approval of this Recovery Plan, the Recovery Team should meet as necessary to monitor Plan implementation and meet with Site Conservation Teams, the Governance Committee, and other conservation partners.
- 5.2 Establish a Governance Committee.** If recovery of Preble's is to be achieved, it must take place within a landscape that is largely dominated by human activities. Overall, organization and communication strategies will be important between agencies, local governments, private landowners and citizens within Wyoming and Colorado to achieve the objectives of the Plan. A Governance Committee should be formed to assist with the oversight and implementation of this Recovery Plan with duties that include:
- Clarify responsibility and accountability
 - Identify and secure funding of the recovery plan
 - Facilitate communication and cooperation
 - Conflict resolution
 - Encourage and develop cooperative agreements
 - Encourage and support progress toward achievement of the Recovery Plan
 - Monitor progress
 - Help establish Site Conservation Teams
 - Participate in developing the long-term management plan prior to delisting

A main priority will be to identify and secure funding for implementing this approved Recovery Plan.

The Governance Committee should be formed from business and industry leaders, directors and officials from Federal, State, and local governments, and others involved in the management and conservation of this subspecies. In addition to their role in securing funding, the Governance Committee should provide political support for this Recovery Plan through developing agreements, evaluating progress, establishing funding priorities and facilitating communication and cooperation between the private and public sectors. Due to the importance of this level of coordination, the Governance Committee should be formed by the Regional Director, FWS, Region 6, within 6 months of the signing of the Recovery Plan.

- 5.3 Establish Preble's Site Conservation Teams.** Local governments, in conjunction with the Recovery Team and the Governance Committee, have the opportunity to establish

these teams. These teams may be tailored to the individual site, and participation may include a wide range of stake holders, including private landowners and agencies. If teams are not established within 1 year of Recovery Plan approval, the FWS and Governance Committee will take the lead in establishing the Site Conservation Teams.

These teams will work directly with the FWS to delineate the boundaries of the designated recovery sites, develop the Threat Abatement Management Plans for each designated recovery sites (Task 3.3), and complete/administer the task of monitoring populations and habitat as directed by the Preble's Population and Habitat Monitoring Plans (Tasks 1.2 and 2.2). The Preble's Site Conservation Teams may work with more than one designated recovery population, and could be closely tied to existing county Habitat Conservation Plan groups. These teams also will participate in developing the long-term management plan and agreement for Preble's prior to delisting (Task 4.1 & 4.2).

To ensure implementation of Recovery Tasks and to facilitate information sharing and coordination among participating organizations, the Recovery Team will hold meetings attended by all Site Conservation Teams (or a representative) as needed.

- 5.4 Provide Updated Information on Status of Recovery Populations.** All parties managing, monitoring, conducting research and surveying for Preble's populations will need to provide written reports to the FWS. Activities conducted under Section 10(a)(1)(A) permits will, as standard for such permits, be required to submit annual reports. This information will need to be compiled by the FWS and added to the FWS web-site.
- 5.5 Develop and Implement a Public Information and Communication Strategy for a Wide Range of Audiences.** Provide information on Preble's ecology, conservation, threats and threat abatement strategies to increase public awareness and understanding. *Information should also be provided on protection of stream corridors on a landscape level.* Develop strategies, in addition to placing information on agency websites, for distributing this information to a wide range of audiences. .
- 6.0 Implementing Laws, Regulations, and Authorities.**
 - 6.1 Promote Compliance and Enforcement of ESA Laws and Regulations Related to Preble's.** Private landowners and local agencies need to be provided information on ESA regulations. Specific information on regulations applicable to the private sector and non-Federal agencies, can be found on the FWS web-site or from local FWS offices; refer to Section 9 of the ESA.

Section 7

Section 9

- 6.2 Enforce Laws (Federal, State, Local) and Other Agreements Protecting Preble's Populations and Their Habitat.** Enforcement needs should be coordinated between Federal, State, and local agencies. Sufficient resources to conduct law enforcement activities relating to Preble's enforcement and conservation are needed. The effectiveness of Federal, State, and local enforcement efforts in protecting Preble's populations and conserving Preble's habitats within designated recovery populations, areas protected under the provision of HCP's and areas covered by other permits, easements, or agreements needs to be monitored and assessed.
- 6.3 Utilize Program and Funding Support. Federal agencies should use existing programs and funding to conserve existing Preble's populations, and implement this plan.**
- 6.3.2 Utilize Environmental Protection Agency Section 516 Grants to Conserve Prebles.** The EPA Section 516 Grants are available to inventory water quality and restore aquatic habitats on non-Federal lands and can provide incentives for Preble's conservation. The EPA should request grants to be submitted for restoration/conservation of Preble's habitat and should give high priority for funding these grants.
- 6.3.3 Access NRCS Programs to Conserve Preble's.** The NRCS has appropriations in WHP and EQUIP programs that are available to provide landowners means to stabilize soils and improve water quality along stream systems. The NRCS should give high priority to funding restoration of riparian habitats in their WHP and EQUIP programs within the designated recovery populations. The NRCS also should provide technical assistance to landowners to maintain Preble's habitat in riparian areas. Currently, NRCS is providing technical assistance and FSA is providing funds to assist landowners in constructing tile drains, cementing irrigation ditches, and channelizing streams, all of which removes Preble's habitat. The NRCS should withdraw support of such projects where negative impacts to Preble's may occur. NRCS should prioritize support through the CRP program to restore habitats within designated recovery populations.
- 6.3.4 Evaluate Impacts of COE 404 Permit Programs.** The COE provides permits for wetland filling under Section 404 of the Clean Water Act. The COE must review every 404 permit application for potential impacts to the Preble's and should not provide permits for such actions unless impacts have been modified or reduced through consultation with the FWS. The COE should deny all fill permits for actions within designated recovery populations unless the impacts are small or have been eliminated or reduced to minimal levels. The COE also should provide funding to support management of populations at Chatfield State Park.

6.3.5 Federal Highway Administration/Colorado Department of Transportation / Wyoming Department of Transportation. Construction and maintenance of highways conducted by Colorado Department of Transportation (CDOT) and Wyoming Department of Transportation (WDOT) and funded by the Federal Highway Administration (FHWA) can impact riparian zones occupied by Preble's. The FHWA should review all projects they fund and ensure that impacts to Preble's have been eliminated, reduced to a minimal level, and/or mitigated. Establishment of mitigation banks should be evaluated to increase opportunities for protection and enhancement of designated recovery populations. The CDOT and WDOT should review their projects and ensure that they identify potential impacts to Preble's and that they incorporate measures to modify or reduce these impacts early in the design phase.

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Glossary

Abundance Estimate. An estimate of the number of individuals within a specific area.

Adaptive Management. Refers to a process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in management plans. In most management situations, there is little past experience, or knowledge is lacking for some aspects of Preble's biology. Although research is recommended in this plan, research may take years to complete. The only practical approach is adaptive management, where some type of management is specified, population responses are monitored, the outcome is evaluated, and management is readjusted accordingly. This process should continue until definitive research is completed, and wild self-sustaining Preble's populations are documented.

Census Population. The population of animals within a defined geographic area that is determined by the completion of a statistically based population estimator. (I don't think I know what this means - can we just say population estimate or population? This term is used twice and I don't know if it needs to be.)

Collaborative process. The process of individuals, public (organizations?) and governmental groups working together to resolve an issue. For example, the Service, Colorado Division of Wildlife and Wyoming Game and Fish and others, will work with local governments and implementation teams to address tasks identified within the Plan.

Complexity. Made up of many interconnected or interrelated parts. For example, an area occupied by Preble's that includes mainstem streams and a network of tributaries of diverse size, and a variety of vegetation types is considered to have habitat complexity.

Conservation Status. The status of the preservation, protection, and management of an environment that takes into account recreational and aesthetic needs, in addition to preserving the natural fauna and flora and allowing for harvesting of natural resources and agriculture. (Our use is specific to Preble's and other rodents - this defines the term for an "environment.")

Conserve. In general, to keep natural resources in a safe or sound state, and avoid wasteful or destructive uses. Specific to the Act, to use all methods and procedures necessary to bring a listed species to the point at which the measures provided pursuant to the Act are no longer necessary.

Cooperative Agreement. An agreement between governmental agencies, organizations, or private individuals, that outlines responsibilities, authorities, limitations, future actions and funding within a given time period.

Cross-Site. Having application to more than one Preble's population. For example, the population and habitat monitoring plans will be used for all Preble's populations, and will have a cross-site function.

Delineated. For this plan, the process that establishes the exact boundaries of a designated Preble's recovery population. For example, the large designated Preble's recovery population in the upper Monument Creek drainage may be delineated as the legal boundary of the U.S. Air Force Academy (would it just be the specific streams on the Academy?), and x miles of x streams lying north and east of the Academy.

Demography. The study of populations, size, density, distribution, trend and other vital statistics of the population.

Designated. For this plan, the selection of recovery populations and sites required to delist the species at the landscape level within river drainages, or hydrological units. For example, a large Preble's recovery population is *designated* in the upper Monument Creek drainage.

Distribution. The occurrence of a species over that total area in which it occurs, that is, its range.

Effective Population Size.

Succession. The natural, sequential change of species composition of a community in a given area. For example, community development begins with pioneering species, which are replaced by a series of other species, until a relatively stable community is established that is in equilibrium with local conditions. However, the introduction of disturbances (fires, floods, etc) to the existing conditions, may reset the communities to the pioneer species.

Ecological Process.

Economies of Scale. Relative savings realized when the size of an activity, enterprise, etc. is increased so that average cost per unit declines over time. An example in the case of Preble's would be public and/or private landowners combining efforts related to a designated recovery population.

Ecosystem. A dynamic complex of plant, animal, fungal, and microorganism communities and their associated nonliving environment interacting as an ecological unit.

Exotic. Introduced from another location. Plants and animals not native to the location currently found.

Fragmentation. The disruption of extensive habitats into smaller, isolated patches. Fragmentation has two negative components: loss of total habitat area, and isolation of remaining habitat patches.

Front Range A mountain range on the eastern edge of the Rockies in north-central Colorado and southeastern Wyoming. The term is commonly used to refer to the area where the eastern boundary of the Rocky Mountains meets the western boundary of the Great Plains, the Colorado piedmont. Within Colorado and Wyoming, much of the population and growth is located in this area, including the cities of Colorado Springs, Denver, and Fort Collins, Colorado, and Cheyenne, Wyoming.

Federal Lands. Land owned, or administered, by the U.S. government agencies. For this plan, this includes, but is not limited to, lands owned by the U.S. Forest Service, Bureau of Land Management, Fish and Wildlife Service, Department of Defense, and Department of Energy.

Geographical Information System (GIS). A computer system capable of storing and manipulating spatial data.

Geomorphology. The science that deals with the land relief features of the earth's surface, and seeks a geological interpretation of them. (Used once).

Habitat. Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.

Habitat Fragmentation. See fragmentation.

Habitat Conservation Plan(s) (HCP). Under section 10 of the Act, a planning document that is a mandatory component of an incidental take permit application. The process is an opportunity to provide species protection and habitat conservation within the context of non-Federal development and land use activities. Overall, the HCP process promotes negotiated solutions to endangered species conflicts, and provides an alternative to litigation.

Hibernaculum. A shelter used by an animal during the winter by a dormant animal. For Preble's, hibernating animals enter an underground nest in the fall, where they remain until late spring. Successful Preble's hibernaculum appear to be located above the riparian zone, to avoid flooding during the normal spring run-off.

Historic Range. The area known to have been used by an animal within modern times.

HUC (Hydrologic Unit Code). Watershed are delineated by the U.S. Geological Service using a nationwide system based on surface hydrologic features. This system divided the country into 21 regions (2-digit), 222 subregion (4-digit), 352 accounting unites (6-digit), and 2262 cataloguing usints (8-digit). Eight digit HUC's are used within the Preble's Plan as a means of assessing distribution of populations and assessing risks to populations from storm events.

Hydrology. The science of the properties of water, including the distribution and circulation of water on the surface of the land, in the soil, underlying rocks and the atmosphere.

Immigration. The movement of individuals from other areas into a given area.

Implement. To give practical effect, and ensure actual fulfilment by concrete measures.

Landscape. An expanse of natural scenery.

Mean. The sum of a set of scores divided by the number of scores, the average For example, the mean of the numbers 13, 9, 12 and 10 is 11 (sum of 44 divided by 4).

Mesic. Relating to conditions between wet or dry, moderately moist. The specific quality of being adapted to moderate moisture.

Model. A representation of reality, based on a set of assumptions, that is developed and used to describe, analyze, and understand the behavior of a system.

Monitoring. The process of collecting information to track changes over time.

Monitoring Plan. A detailed program of action to collect information over time.

Monitoring Protocol. For this plan, the established method of collecting information to track changes in populations and habitat.

Morphology. The study of the shape, general appearance, or form of an organism.

Noxious Weeds. Those plants designated by the State of Colorado, State of Wyoming, or local government under weed control regulations.

Overstory. The highest limbs and foliage of a tree, and consequently extending and relating to the upper layers of a forest canopy.

Occupancy. Within this Plan, the occurrence of Preble's within a given area. One individual within a given area, is equal to "occupancy."

Percent Occupancy. The portion of sampling units that with presence of at least one Preble's. For example, if 8 of 10 one-kilometer study sites within a Preble's population have at least one Preble's at the time of survey, the population has a 80% occupancy rate for that survey.

Peer Review. Review by others knowledgeable in the subject. For this Plan, the Team and Service received comments on various aspects of this Plan from knowledgeable experts not involved in the development of this Plan.

Persistence. The capacity of a population to maintain numbers and distribution over time.

Prescribed Fire. Prescribed fires is the controlled application of fire under specified environmental conditions (the "prescription") to accomplish specific natural resources management objectives. Fires may be planned, or unplanned ignitions. The use of unplanned ignitions are predicated on an established fire management plan specific to the area, and are usually manned to agency standards as long as they stay within the prescription. Once any prescribed fire exceeds the parameters established in the prescription, it is either controlled immediately, or if it escapes control, becomes classified as an escaped fire which triggers emergency suppression response that same as any other wildfire.

Population. A collection of individuals per unit area.

Population viability. The probability that a population will persist for a specific period of time.

Range. The region to which a plant or animal is native.

Recovery. As provided by the Endangered Species Act and its implementing regulations, the process of returning a threatened or endangered species to the point at which protection under the Endangered Species Act is no longer necessary.

Recovery Plan. As provided by the Endangered Species Act, a plan for management of a threatened or endangered species that lays out the steps necessary to recover a species.

Recovery Team. A team made up of experts appointed by the U.S. Fish and Wildlife Service whose charge is development of a draft recovery plan. The team serves only in an advisory capacity to the Service, with the Service responsible for producing a final approved recovery plan.

Recruitment. The addition of individuals to a population from birth and immigration.

Richness. The number of species in a community.

Riparian. Of or relating to a river; specifically applied to ecology, “riparian” describes the land immediately adjoining and directly influenced by streams. For example, riparian vegetation includes any and all plant-life growing on the land adjoining a stream and directly influenced by that stream.

Self-Sustaining Wild Population. For this Plan, a population of animals that maintains itself through natural reproduction within its habitat.

Stochastic. Random or uncertain.

Sub-drainage. A smaller drainage within a major river drainage, such as the Monument Creek drainage within the Arkansas River drainage or Plum Creek Drainage within the South Platte River drainage.

Subspecies. A variety of organisms distinguished from other varieties of the same species. Often an incomplete tendency toward reproductive isolation is a factor in designating and naming a subspecies.

Sympatric. Occurring together in the same geographic area. The term is used to describe the geographical distribution of organisms that either coincide or overlap.

Take.

Taxa. Plural of taxon.

Taxon. Any grouping within the classification of organisms, such as species, genus and order.

Taxonomy. The classification of fossil and living organisms according to knowledge of their evolutionary relationships.

Team. The Preble’s Meadow Jumping Mouse (Preble’s) Recovery Team.

Threat assessment. The identification, evaluation, and raking of stresses and sources of stress to populations, species, ecological communities, or ecosystems at a site or within a landscape.

Transitional Slope. The habitat that exists between the riparian zone and the dry upland habitat, and includes important habitat for the Preble’s.

Type I Error. The mistake of rejecting the null hypothesis when it is true.

Type II Error. The mistake of failing to reject the null hypothesis when it is false.

Upland. For this plan, “upland” habitat refers to the dry habitat that are often grasslands surrounding a riparian zone. The upland habitat, in context with the riparian and transitional habitat , are important habitat components for Preble's.

Viability. The ability of a population to persist through time.

Wild. Living in a state of nature and not ordinarily tame or domesticated.

Wild Self-Sustaining Population. For this Plan, a population of animals that maintains itself through natural reproduction within its habitat.

Xeric. Of or relating to perennially dry conditions or the specific quality of being adapted to dry conditions.

APPENDIX

Appendix A. Summary of Agency and Public Comments Recieved on the Draft Preble's Meadow Jumping Mouse Recovery Plan.

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Appendix B Research

- 1.3 **Conduct research on the taxonomy, distribution, demography, and ecology of Preble's Populations.** A research program on Preble's taxonomy, distribution, demography, and ecology whose primary objectives are to enhance understanding of Preble's biology and to assess how land management practices affect Preble's population viability is needed. Information gained from these studies will facilitate recovery by improving the ability to identify the distribution and range of Preble's, more clearly identify management practices that enhance Preble's populations, and to identify threats to the persistence and distribution of populations.

1.3.1 **Conduct research on Preble's taxonomy.**

1.3.1.1 Conduct studies to develop a protocol to differentiate Preble's from *Z. princeps princeps* using morphological characteristics measurable on live animals in the field. Currently, the identification of Preble's from *Z. p. princeps* can best be verified using skull measurements. Research should be conducted is needed (Shirley 5/23) to identify morphological characteristics that can be used to identify Preble's on live animals in the field to eliminate the need for sacrificing animals for identification.

1.3.1.2 Research may be needed to determine how Preble's can be readily distinguished morphologically from the subspecies *Z. hudsonius campestris* and *Z. h. luteus*, to clarify the northern and southern range and distribution of Preble's.

1.3.1.3 Conduct research to develop protocols for distinguishing *Z. h. preblei* from *Z. princeps princeps* and other subspecies of *Z. hudsonius* through genetic analyses. This will eliminate the need for sacrificing animals for identification. The combination of genetic and morphological characteristics would also provide a more definitive identification of Preble's.

1.3.1.4 Conduct research to describe the potential relationships among taxa of closely related species and subspecies of Preble's, through systematic and molecular genetic studies.

1.3.1.5 Conduct research to describe the potential differences among populations of *Z. h. preblei* through systematic and molecular genetic studies. Studies of potential differences among various populations of *Z. h. preblei* will help identify the genetic viability of individual populations and will help guide possible future relocations or translocations of the species between populations.

1.3.2 Conduct research on distribution of Preble's populations.

1.3.2.1 Design and conduct studies to better define elevational and ecological boundaries of the range of Preble's. Current information indicates that the upper elevational limit of Preble's is about 7600, however, more information is needed to verify this assumption.

1.3.2.2 Design and conduct studies to determine the distribution of Preble's in relation other closely related species. Studies need to be designed and conducted to determine if and where *Z. h. preblei* occurs sympatrically, allopatrically, or parapatrically with *Z. princeps*, *Z. h. campestris*, and *Z. h. luteus*.

1.3.2.3 Develop and evaluate new methodologies for detecting the presence of Preble's (e.g., camera traps, hair traps). Simpler, faster, more efficient and inexpensive survey and monitoring methods will be beneficial to conduct efficient and economical surveys.

1.3.3 Design and conduct studies to provide information on the demography of Preble's.

1.3.3.1 Conduct studies to estimate over-summer survival, over-hibernation survival, density, and their trends.

1.3.3.2 Investigate possible factors affecting the demographic parameters listed above. Factors that affect the various demographic parameters described in Task 1.3.3.1 need to be identified to provide information on how habitat can be improved to support high fitness populations of Preble's. These factors include, but are not limited to: weight, sex, age, abundance (i.e., density dependent response), weather, predation, competition, exotic species, parasitism, and disease.

1.3.3.3. Study dispersal behavior of Preble's. Dispersal is a key process in metapopulation theory and to maintain genetic diversity between isolated subpopulations. Key questions to address through research are to describe dispersal of individual Preble's among populations, such as, but not limited to identify who disperses, timing of dispersal, and estimate rate of dispersal.

1.3.3.4. Design and conduct behavioral and physiological studies to provide information on the mechanisms driving habitat selection.

1.3.4. Conduct research on the ecology of Preble's populations.

1.3.4.1. Does the presence of *Mus musculus* (house mice) and *Rattus norvegicus* (Norway rats) eliminate the presence or suppress the density of Preble's ?

1.3.4.2. Does the presence of *Zapus princeps princeps* eliminate the presence or suppress the density of Preble's?

2.3 **Conduct research on Preble's habitat.** A research program on Preble's habitat whose primary objectives are to enhance understanding of Preble's habitat and to assess how land management practices affect Preble's population viability is needed. A experimental research program must be designed. Information gained from these studies will facilitate recovery by improving our ability to more clearly define and qualify Preble's habitat, more clearly identify management practices that enhance Preble's habitat, and help develop threat abatement management strategies for Preble's habitat.

2.3.1 **Identify and describe habitat used for nesting, breeding, cover, travel, feeding, dispersal, and hibernation.**

2.3.1.1 What habitat results in highest density and survival of Preble's?

2.3.1.2 What dispersal habitat results in the most successful dispersal?

2.3.1.3 What habitat components result in the highest hibernation survival?

2.3.2 **Design and conduct studies to provide information on the effects of habitat features (listed above) on the demography of Preble's.**

2.3.2.1 Is Preble's density increased with increasing shrub cover?

2.3.2.2 Are Preble's movement patterns and survival influenced by shrub density adjacent to open water? in adjacent upland areas?

2.3.2.3 Are Preble's movement patterns and survival influenced by composition of upland vegetation adjacent to riparian vegetation?

2.3.3 **Evaluate effects of habitat management techniques and threat abatement strategies to maintain and enhance habitat, and the effect on distribution and demography of Preble's.**

2.3.3.1 Would protection of shrub density in upland areas increase survival?

3.6. **Conduct research to evaluate effects of threat abatement strategies**

3.6.1. Evaluate impacts of non-native predators.

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III. IMPLEMENTATION SCHEDULE

In Section III of this Plan, tasks from Section II have been assigned an estimated cost, priority number and task duration.

Where possible, tasks are ordered in descending priority, at least in the sense that one or more tasks may have to be started or completed before the other tasks can be accomplished. However, it should be apparent that no linear hierarchy can suitably express the complex interrelationships between tasks.

Some tasks likely will take considerable time to complete, and some are going to be much more difficult to accomplish because they involve more diverse interest groups. Tasks that are mostly or solely within the jurisdiction of governmental agencies are listed before other, similar tasks involving private entities because the former should put the focus of recovery actions on public lands and agencies.

Definition of the priority numbers:

- Priority 1. An action that must be taken to prevent extinction or to prevent a species from declining irreversibly in the foreseeable future.
- Priority 2. An action that must be taken to prevent a significant decline in species populations or habitat quality or some other significant negative impact short of extinction.
- Priority 3. All other actions necessary to meet the recovery objective.

Definition of task durations:

- Continual. A task that will be implemented on a routine basis once begun.
- Ongoing. A task that is currently being implemented and will continue until action is no longer necessary.
- Unkown. Either task duration or associated costs are not known at this time.

Key to Acronyms used in the Implementation Schedule:

All	Possible combination Federal, state and local listed below
AF	U.S. Air Force (Warren AFB, Academy)
BLM	Bureau of Land Management
CDOW	Colorado Division of Wildlife
COE	Corp of Engineers
CSU	Colorado State University
DOE	Department Of Energy, Rocky Flats
GC	Governance Committee
HCP's	Habitat Conservation Plans
Local	Local governments
NWR	National Wildlife Refuge
NRCS	Natural Resource Conservation Service
Museum	Denver Museum of Nature and Science
Private	Private land owners
Pops.	Populations
RT	Recovery Team
SCT	Site conservation team(s)
TBD	To be determined
TNC	The Nature Conservancy
USFS	Forest Service
USAFA	U.S. Air Force Academy
USFWS	U.S. Fish and Wildlife Service
WG&F	Wyoming Game and Fish Department

Implementation Schedule for Preble's Meadow Jumping Mouse. Draft 26 July 2001, updated 11 December 2003

Priority Number	Task Number	Task Description	Task Duration	Minimum List Of Potential Partners	Total Costs	Costs (\$1,000)			
						Year 1	Year 2	Year 3	Year 4
	1.0	Populations of Preble's							
	1.1	Complete selection & delineation of recovery populations							
2	1.1.1	Preble's database	Ongoing	USFWS, CO & WY	20	5	5	5	5
2	1.1.2	Identify existing small pops: assess size & extent	3 Years	CDOW, WGF, Local, Private, AF, FS	600	200	200	200* may be part of HCP's	
2	1.1.3	Finalize population criteria & designate sites	3 Years.	USFWS, FS, CDOW, WGF, SCT. SCT partners will vary by site and may include federal, state, local and private, see 5.3.	TBD by year 2				
2	1.1.4	Notify Property Owners	3 Years	USFWS, WGF, CDOW, Local, SCT	15	5	5	5	
2	1.1.5	Delineate all recovery population sites	4 Years	USFWS, Local, SCT, FS	310	10	50	150	100
	1.2	Monitor all recovery populations							

2	1.2.1	Develop a Preble's population monitoring protocol	Ongoing, funded in 2003 and included in Plan	USFWS, CDOW, WGF, CSU, USAFA	20 includes costs from 2003	10			
2	1.2.2	Monitor designated large medium recovery populations	Ongoing	USFWS, FS SCT, CDOW, WGF, USAFA, Local, Private	2,000	200	300	500	1,000* Costs likely to be near this level for 6 more years
2	1.2.3	Monitor designated small recovery populations	Ongoing	USFWS, FS, Warren AFB, CDOW, WGF, Local, Private, SCT	included in 1.2.2				
	1.3	Preble's Research							
	1.3.1	Taxonomy Research							
3	1.3.1.1	Live animal field taxonomy	1 Year	All	10	10			
3	1.3.1.2	Morphology of <i>Z. h.</i> , <i>campestris</i> & <i>Z. h. luteus</i>	1 Year	All	25	25			
3	1.3.1.3	Develop genetic markers for <i>preblei</i> , <i>princeps</i> , <i>luteus</i> & <i>campestris</i>	Ongoing, project initiated in 2003	Museum, WGF, USFWS, DOE	180 includes funds from 2003	100			
3	1.3.1.4	Variation among <i>preblei</i> populations	3 Years	All	part of 1.3.1.3				
3	1.3.1.5	Systematic & molecular genetic studies	3 Years	All	10			10	

	1.3.2	Distribution Research							
2	1.3.2.1	Define elevational & ecological boundaries of <i>preblei</i>	2 Years	All	200			100	100
2	1.3.2.2	Distributional relationship of <i>preblei</i> , <i>princeps</i> , <i>luteus</i> & <i>campestris</i>	2 Years	All	could be included with 1.3.2.1 at minimal increase				
2	1.3.2.3	Develop non-invasive methods of collection	2 Years	All	100	50*	50*		
	1.3.3	Design & conduct studies on demography							
2	1.3.3.1	Estimate survival density & their trends	3 Years	All	75 per site per year (min 3 sites)				
2	1.3.3.2	Determine factors affecting demographics of 1.3.3.1	3 Years	All	Costs included in 1.3.3.1				
2	1.3.3.3	Dispersal behavior	3 Years	All	75 per site per year (min 3 sites)				
2	1.3.3.4	Preble's behavior & physiology	2-3 Years	All	50 per site per year				
	1.3.4	Ecology Research							
2	1.3.4.1	Impacts of non-native small mammals	2 Years	All	50 per site per year				
3	1.3.4.2	Impacts of <i>princeps</i> on <i>preblei</i>	2 Years	All	45 per site per year (min 3 sites)				
	2.0	Habitat							

2	2.1	Map the length and width of habitat of designated recovery populations	4 Years	USAFA, USFWS, CDOW, WGF, Local, SCT, Private	1,300	100	200	500	500
	2.2	Monitor habitat of all designated recovery populations							
2	2.2.1	Develop a Preble's habitat monitoring protocol	Ongoing, project funded In 2003	USAFA	90 includes costs from 2003	10			
2	2.2.2	Monitor habitat of all recovery populations	Continual	USFWS, FS, BLM, AF, CDOW, WGF, Local, SCT, Private	1,000	50	50	450	450
	2.3	Conduct research on Preble's habitat							
	2.3.1	Identify and describe Preble's habitat							
2	2.3.1.1	Habitat influence on Preble's survival and density	2 Years	All	Funding included in 1.3.3.1				
2	2.3.1.2	Habitat influence on Preble's dispersal	3 Years	All	Funding included in 1.3.3.3				
2	2.3.1.3	Habitat influence on hibernation survival	2 Years	All	Funding included in 1.3.3.1				
	2.3.2	Effects of habitat on demography							

2	2.3.2.1	Effects of cover on Preble's density	3 Years	All	75 per site per year (min 3 sites)				
2	2.3.2.2	Influence of shrub density and open water on Preble's movement & survival	3 Years	All	Costs included in 2.3.2.1				
2	2.3.2.3	Influence of upland vegetation on Preble's movement/survival	3 Years	All	Included in 1.3.3.1				
	2.3.3	Evaluate habitat management techniques							
3	2.3.3.1	Evaluate different grazing techniques on Preble's demography	3 Years	All	75 per site				
	3.0	Threat Abatement							
	3.1	Abate threats to designated recovery populations							
2	3.2	Identify threats to recovery populations	Continual	USFWS, SCT, CDOW, WGF, Local, FS, USAFA	Costs included in 3.3				
1	3.3	Develop and implement threat abatement management plans	Continual	SCT, GC	TBD by year 2				
1	3.3.1	Maintain effects of ecological processes	Continual	SCT,GC	Costs included in 3.3				
3	3.3.2	Develop abatement strategies for multiple sites	Continual	SCT,GC	Costs included in 3.3				
	3.4	Protect and conserve non-designated recovery sites							
2	3.4.1	Protect and manage all populations on federal lands	Ongoing	USFWS, AF, FS, BLM	TBD by year 2				

2	3.4.2	Protect and conserve populations on state and local public lands	Ongoing	CDOW, WGF, Local	TBD by year 2				
2	3.4.3	Protect and conserve populations on private lands	Ongoing	Private, IRS	Possible future funding available under task 3.5				
	3.5	Develop and implement economic and social incentives							
3	3.5.1	Encourage development of recovery funds	Continual	USFWS, GC, CDNR, SCT, Recovery Team, WGF, Local, DOI, Congress, State Legislature	TBD				
3	3.5.2	Create tax incentives	Continual	Local, State, Congress	TBD				
3	3.5.3	Create awards and rewards system	Continual	USFWS, CDOW, WGF, Local, CDNR	TBD				
	3.6	Evaluate effects of threat abatement strategies							
2	3.6.1	Evaluate impacts of non-native predators	2 Years	All	60 per site per year				
	4.0	Long-Term Plans							
3	4.1	Preble's Management Plan	Immediately prior to delisting	All	TBD				

3	4.2	Delisting Coop Agreement	Immediately prior to delisting	All	TBD				
	5.0	Organization and Communication Strategies							
	5.1	Maintain a Recovery Team	Ongoing	USFWS	80	20	20	20	20
2	5.2	Governance Committee	Continual	USFWS, FS, CDOW, WGF, Local, Private	TBD				
2	5.3	Conservation Teams	Continual	USFWS, Local, CDOW, WGF, SCT, RC, GC	TBD				
3	5.4	Update Preble's information	Ongoing	All	20	5	5	5	5
3	5.5	Public information system	Ongoing	USFWS, Local, CDOW, WGF, AF, FS, BLM, NRCS	200	50	50	50	50
	6.0	Compliance and Enforcement	Ongoing		800	200	200	200	200
2	6.1	Promote compliance and enforcement							
2	6.2	Enforce existing laws		USFWS, COE, CDOW, WGF, FS, BLM, Local	200	50	50	50	50